2075-2A NOISE-GAIN ANALYZER

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APPLICATION NOTES

Number 33000
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Using The EATON 2075-2A to Measure Noise In High Frequency Receivers and Mixers

In anticipation of high frequency receivers with relatively high output frequencies, Test Configuration 6 was included in the Eaton 2075-2A Noise-Gain Analyzer.

In this test configuration, the device under test (DUT) is a mixer or receiver whose noise performance we wish to measure and whose output IF is greater than 1850 MHz. Note that local oscillator #1 (LO_1 in Fig. 1) must be a GPIB compatible sweeper or synthesized signal generator. It must be stable, clean and low noise to be suitable as a local oscillator for noise measurements. Note also that even though the fixed frequency local oscillator #2 (LO_2) may or may not be physically a part of the DUT, it must be considered nonetheless as part of the DUT. The isolator in front of the mixer (LO_1) helps keep mixer products from going back into the DUT.

This is always a single sideband measurement. So if the image frequency is not filtered out by the DUT then a suitable filter must be placed between the noise generator and the DUT. The filter loss is then accounted for by using loss compensation in the 2075-2A. Note that since the filter is in front of the DUT it is not part of the second stage calibration. The calibration set-up is shown in Figure 2. During calibration one simply bypasses the filter and the DUT.

An important point must be made here. Even though the measurement must always be single sideband the 2075 actually performs a double sideband measurement with respect to the IF of the DUT (IF_2 in Fig. 1). This means that the 2075 will measure the noise performance of the DUT over a given RF range by sweeping LO_1 across the corresponding IF range of IF_2. Thus, the IF that one enters into the 2075 (IF_1) must be a low frequency suitable for a double sideband measurement.

Several other points must be made here. First, one must be aware that whenever lossy elements such as mixers, filters, attenuators, etc. are added to the front end of the 2075 as part of the measurement system, the second stage noise figure will increase. A larger noise figure means a Y-factor closer to one, which in turn means that the system is more susceptible to uncertainties in the measurement, especially in the corrected mode. These uncertainties will become more pronounced when the DUT is lossy (such as a mixer) but will be less pronounced if the DUT has some reasonable gain, say 20 dB. Also, one must choose the local oscillators carefully since these will add their own noise to the system. Finally, all components used should have the lowest VSWR possible to maximize the power seen at the detector and the Y-factor measured.

The second point has to do with calibration. In this configuration, the RF is usually very high—higher than 26 GHz. This means that the noise source used is generally a gas-discharge noise generator. These generators have waveguide coupling structures and thus can only be used within the bandwidth of that particular waveguide. Therefore, if the lowest usable frequency of the gas noise source is 26 GHz for example, we must use another noise source to perform the calibration at the frequencies of IF_2 if it is desired to have a corrected measurement.

One may use the following procedure to perform the calibration. Choose an ENR table, say Table 1 (not Table 0). Next, select a solid state noise source which is calibrated over a range that includes the range of the IF of the DUT. Enter the ENR of this noise source into Table 1 to cover this range. Then enter the ENR of the gas-discharge noise generator at the higher frequencies to cover the RF input range. Perform the second stage calibration using the solid state noise source and the set-up of Figure 2. For the actual measurement, disconnect the solid state noise generator and connect the gas-discharge noise generator. This procedure is necessary since, as part of the corrected measurement, the 2075 must find the gain of the DUT. It must look up the ENR table to find the ENR that was used during the calibration. With this procedure all the proper values will be there.

Note that the highest RF which may be entered in to the 2075-2A is 65.535 GHz. What if the RF range is higher than this? In Test Configuration 6 (as well as Configuration 4 or 5), one may enter the ENR of the noise generator at the higher RF range into some RF range less than 65.535 GHz.

Next, enter the fixed L.O. frequency (LO_2) such that the difference between LO_2 and the RF will be the actual IF of the DUT (IF_2). For example, suppose our actual DUT has an RF range of 90-92 GHz and a fixed L.O. of 88 GHz which results in an IF range of 2-4 GHz. Then we could use a start frequency of 40 GHz and a stop frequency of 42 GHz and a fixed second L.O. frequency of 38 GHz. This combination will result in the same IF range, i.e. 2-4 GHz. With this choice, one then finds the ENR of his noise generator in the range 90-92 GHz and enters it instead, in the range 40-42 GHz. Thus, the 2075 will have the correct calibration frequencies and will be using the correct ENR for the RF range.

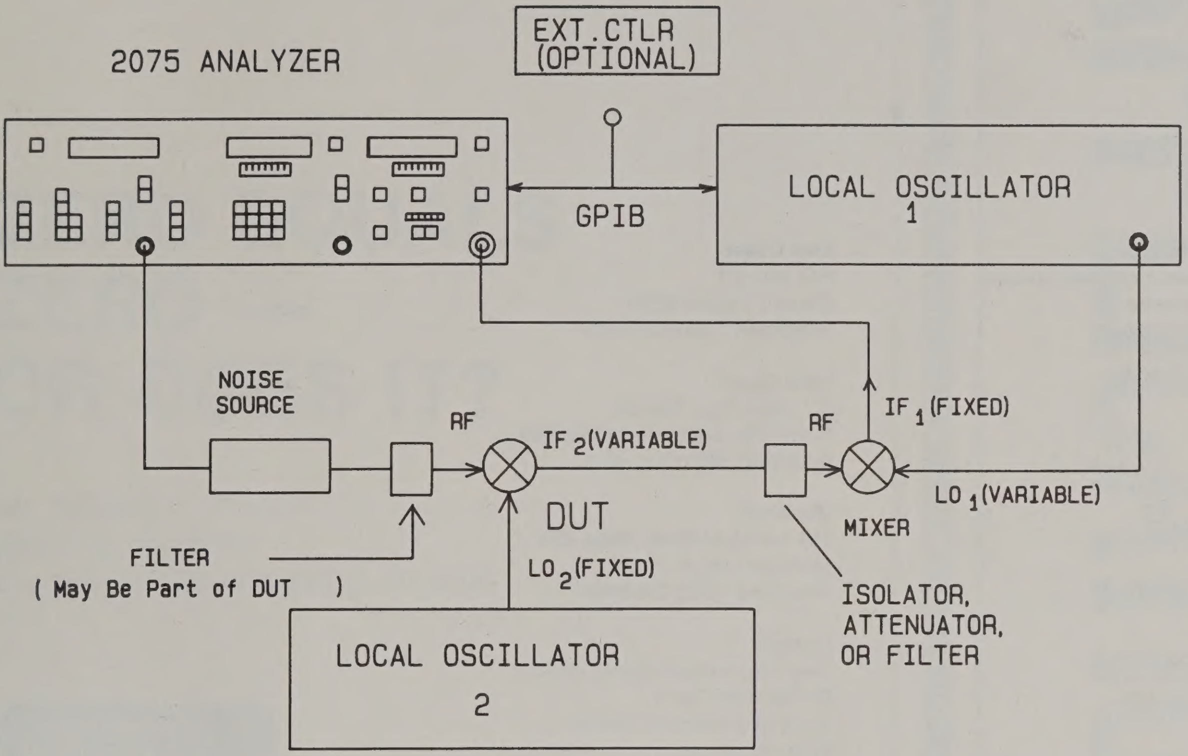

Figure 1 **TEST CONFIGURATION 6 MEASUREMENT**

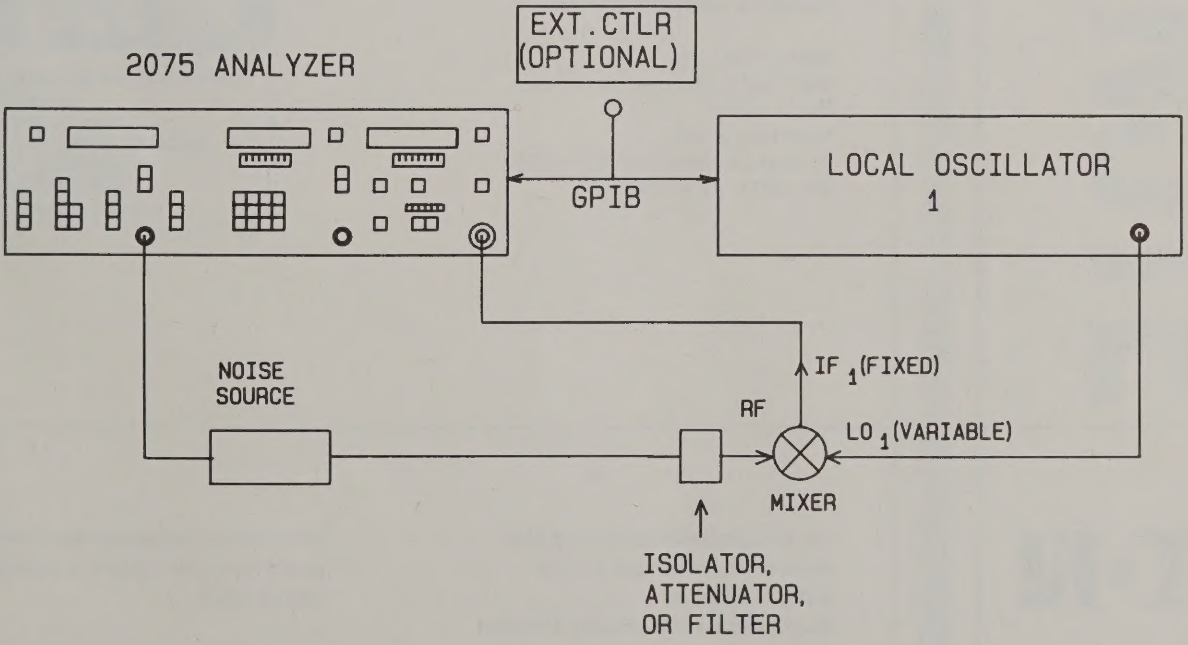

Figure 2 **TEST CONFIGURATION 6 CALIBRATION**

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ZERO EQUALS ZERO — OR DOES IT?

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APPLICATION NOTE

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EATON

Zero Equals Zero — Or Does It?

The Eaton 2075 Noise Gain Analyzer is capable of reading out the noise figure of a device under test (DUT) fully corrected for the effects of second stage (measurement system) noise.

The 2075 does this by first measuring the second stage noise figure and storing the result. It then measures the total system noise figure, including the DUT and the DUT gain, and calculates the DUT noise figure from these data (see Figure 1).

The calculation is usually based on Equation (1), the standard cascade noise figure relation. Figure 2 outlines the derivation of this relation.

$$\boxed{F_1 = F_t - \frac{F_2 - 1}{G_1}} \tag{1}$$

There is a unique situation that occurs during the "second stage calibration" process. To do this measurement, the operator connects the noise generator directly to the input of the measurement system and instructs the machine to "CAL." The instrument steps through the preset frequency range, measuring and storing the second stage noise figure and gain reference at each frequency.

At the end of the CAL run, the 2075 returns to the start frequency and automatically switches over to the "Corrected Noise Figure" mode; that is, it is now operating on Equation (1).

All this occurs before the DUT is inserted between the noise generator and the measurement system. At this time the 2075 measures the second stage noise figure and, at the same time, attempts to correct for it. Mathematically:

$F_t = F_2$

$G_1 = 1$ NOTE: the terms in Equation (1) are expressed as dimensionless ratios, **not** in dB.

Substituting these conditions into Equation (1) results in:

$F_1 = 1$ (or 0 dB)

This is what the 2075 should read at the end of the CAL run before the DUT is inserted **provided** the DUT configuration has been set to one of the three amplifier configurations (1.1, 1.2 or 1.3); that is, a configuration where the instrument assumes the input and output frequencies of the DUT are the same.

If the instrument has been set to one of the receiver configurations (1.4, 1.5, or 1.6) where the output frequency of the DUT is different from the input frequency, then the process is somewhat different, and a reading of 0 dB at the end of the CAL procedure is an accident. The reasons for this are:

1. During the CAL procedure, the instrument is calculating the second stage noise figure using the stored excess noise ratio (ENR) data for the noise generator at the output frequency of the DUT.
2. At the end of the CAL procedure, when the 2075 switches over to the corrected mode, it assumes the DUT is inserted between the noise generator and the measurement system, and it starts using the ENR data for the DUT **input** frequency.

Because the DUT input and output frequencies are usually far removed from each other, the two sets of ENR data are seldom the same; therefore, even though the instrument is correcting for its own (or the measurement system) noise figure, the result will generally not be 0 dB simply because it is using a different ENR for the calculation.

This application note discusses only the amplifier configurations where the theoretical reading in the corrected mode should be 0 dB before the DUT is inserted.

The Uncertain Zero

Determining why, and by how much, the corrected indication deviates from zero before the DUT is inserted requires a review of the underlying mathematics.

The accepted method of determining the magnitude of the variation of a function is to take the partial derivatives of the function with respect to each of the independent variables, multiplied by the random, uncorrelated perturbations in each variable. The process is outlined in Figure 3, and the result for measurement Equation (1) follows. The derivation of Equation (2) is outlined in Figure 4.

$$\boxed{\Delta F_1' = \frac{F_t}{F_1}\Delta F_t' + \frac{F_2}{F_1 G_1}\Delta F_2' + \frac{(F_2 - 1)}{F_1 G_1}\Delta G_1'} \tag{2}$$

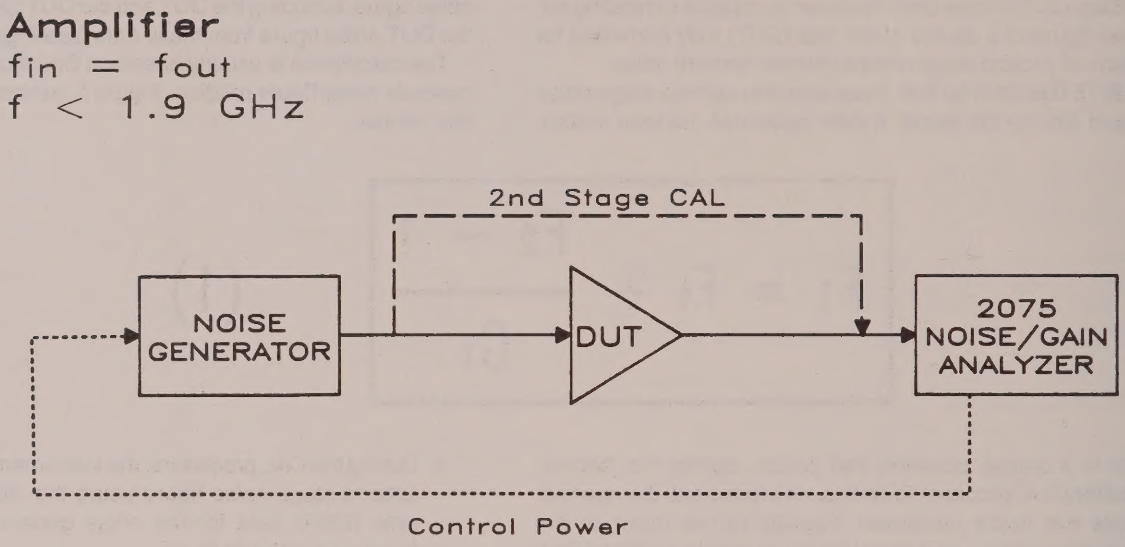
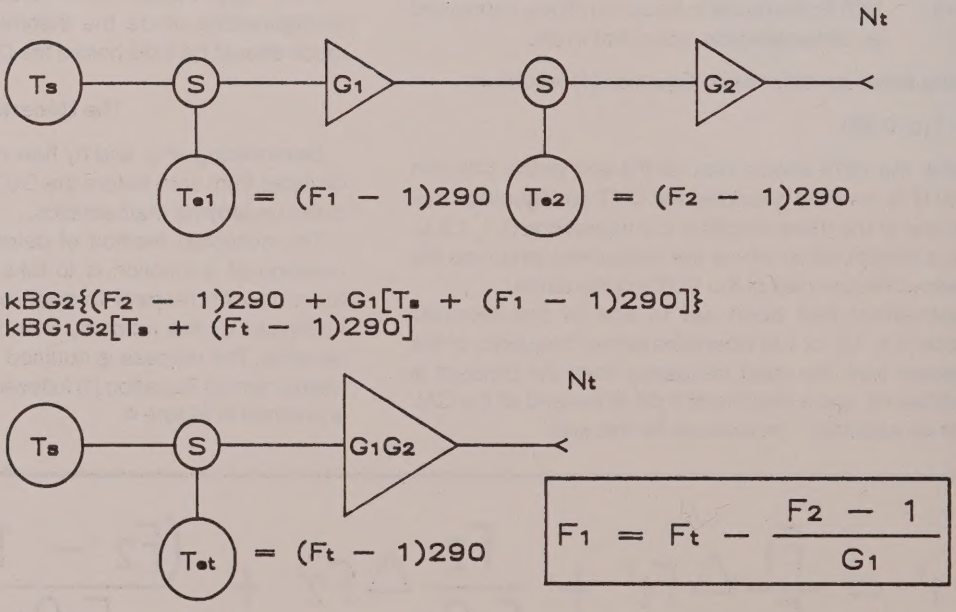


Figure 1 **DUT CONFIGURATION 1.1**



$T_{e1} = (F_1 - 1)290 \quad T_{e2} = (F_2 - 1)290$

$N_t = kBG_2\{(F_2 - 1)290 + G_1[T_s + (F_1 - 1)290]\}$
$N_t = kBG_1G_2[T_s + (F_t - 1)290]$

$T_{et} = (F_t - 1)290$

$$\boxed{F_1 = F_t - \frac{F_2 - 1}{G_1}}$$

Figure 2 **CASCADE NOISE FIGURE**

Given a quantity which is a function of multiple independent variables; for example:

$$A = f(X_1,\ X_2,\ X_3, \ldots X_n)$$

then the variations in A resulting from uncorrelated perturbations in the independent variables is given by:

$$\Delta A = \underbrace{\left|\frac{\partial A}{\partial X_1}\right| \Delta X_1 + \left|\frac{\partial A}{\partial X_2}\right| \Delta X_2 + \left|\frac{\partial A}{\partial X_3}\right| \Delta X_3}, \text{ etc.}$$

These individual contributions may be:
Summed, for an absolute maximum, or
combined by root—sum—squares for the
most probable maximum of ΔA.

NOTE: "∂" indicates a partial derivative.

Figure 3 **UNCERTAINTY OF A QUANTITY AS A FUNCTION OF THE UNCERTAINTIES OF THE INDEPENDENT VARIABLES**

$$F_1 = F_t - \frac{F_2 - 1}{G_1}$$

$$\Delta F_1 = \left|\frac{\partial F_1}{\partial F_t}\right| \Delta F_t + \left|\frac{\partial F_1}{\partial F_2}\right| \Delta F_2 + \left|\frac{\partial F_1}{\partial G_1}\right| \Delta G_1$$

$$\Delta F_1 = \Delta F_t + \frac{\Delta F_2}{G_1} + \frac{(F_2 - 1)\Delta G_1}{G_1^{\,2}}$$

Noting that: $\Delta A' = 4.34 \dfrac{\Delta A}{A}$ where $\Delta A'$ is in dB (see Appendix A)

$$\Delta F_1' = \frac{F_t \Delta F_t'}{F_1} + \frac{F_2 \Delta F_2'}{F_1 G_1} + \frac{(F_2 - 1)\Delta G_1'}{F_1 G_1}$$

Figure 4 **DERIVATION OF THE UNCERTAINTY OF THE CALCULATED DUT NOISE FIGURE (EQUATION 2)**

A certain amount of care should be exercised in the application of Equation (2) because it is a mixed equation. Most of the quantities are expressed as dimensionless ratios; however, all of the "deltas" are expressed in dB. All such "dB" quantities are indicated as primed (') values in the equation.

Now substitute the values describing the measurement system before the DUT is inserted:

$F1 = 1$
$G1 = 1$

The result is Equation (3):

$$\boxed{\Delta F_1' = F_t \Delta F_t' + F_2 \Delta F_2' + (F_2 - 1) \Delta G_1'} \quad (3)$$

Equation (3) describes the potential magnitude of the drift and random variation of the noise figure indication under the stated conditions when it should, theoretically, read zero:

Corrected measurement mode.
DUT not yet inserted.

Two aspects of Equation (3) should be noted:

1. All three contributions to the overall uncertainty represent uncorrelated, random uncertainties; therefore, the sum, as indicated by the equation, represents the absolute maximum excursion of the indication. The most probable variation from zero is the root-sum-squares (RSS) combination of the three contributions.
2. Under these conditions, the magnitude of the overall noise figure is equal to the second stage noise figure. This may tempt some to consider these uncertainties to be correlated, and, because of the minus sign in the cascade noise figure Equation (1), subtract the two which results in zero uncertainty. This is invalid because the two measurements are taken at different times; therefore, the uncertainties are not correlated.

Zero Can Be Bigger Than Nothing

The simplest way to evaluate this potential variation from zero is to look at some typical situations. The first illustration is typical of DUT Configuration 1.1 (the measurement configuration for an amplifier operating between 10 MHz and 2.0 GHz).

The measurement system, then, is the 2075 by itself, and the second stage noise figure is that of the 2075—about 7 dB.

The results for two smoothing factors will be determined: (a) minimum smoothing where the Y-factor jitter is about 0.15 dB peak-to-peak, and (b) a median smoothing factor of about 64 where the Y-factor jitter is about 0.05 dB peak-to-peak. The results will be given both as a summation and RSS. Note that the jitter is simply a result of the mathematical character of random noise. It has nothing to do with the system stability, and the results assume that the 2075 is perfectly stable; obviously an idealized, impractical condition.

At a 7 dB noise figure using a 15.5 dB ENR noise source, the Y-factor jitter converts to:

Y-factor jitter	Noise Figure jitter
± 0.15 dB	± 0.17 dB (1)
± 0.05 dB	± 0.06 dB (2)

(1) no smoothing
(2) smoothing factor 64

The ENR stability of the noise source has a dB for dB effect on the noise figure jitter. Under laboratory conditions, this is primarily a function of power supply stability. Solid state sources, in general, are rated at a maximum ENR variation of 0.1 dB per percent of voltage variation.

The stability of the 28 volt noise source power supply in the 2075 is rated at ± 0.05 volt which converts to about 0.2%. The maximum instability in the noise source ENR is less than ± 0.02 dB.

The effect of ENR instability on the gain uncertainty is doubled since the noise source establishes the reference and measures the gain at two different times.

Using these data, evaluate the magnitudes of the three "deltas" in Equation (3). This is done both as a summation and RSS in Tables I and II for minimum and median smoothing, respectively.

The uncertainties established in Tables I and II can now be applied to Equation (3) using the following assumed condition:

$Ft = F2 = 5.012$ (7 dB)

The allowable instability in the 0 dB reading is established. Note again that the only two factors considered in this development are the random nature of the noise signal itself and the ENR stability of the noise source. No consideration was given to potential gain and noise performance drift or instability within the 2075 itself.

SOURCE	$\Delta Ft'$	$\Delta F2'$	$\Delta G1'$
MINIMUM SMOOTHING			
NOISE JITTER	±0.17 dB	±0.17 dB	±0.15 dB
ENR (meas)	±0.02 dB	±0.02 dB	±0.02 dB
ENR (ref)	N/A	N/A	±0.02 dB
SUM	±0.19 dB	±0.19 dB	±0.19 dB
RSS	±0.171 dB	±0.171 dB	±0.153 dB

Table I NOISE FIGURE AND GAIN UNCERTAINTIES

SOURCE	$\Delta Ft'$	$\Delta F2'$	$\Delta G1'$
MEDIAN SMOOTHING (64)			
NOISE JITTER	±0.06 dB	±0.06 dB	±0.05 dB
ENR (meas)	±0.02 dB	±0.02 dB	±0.02 dB
ENR (ref)	N/A	N/A	±0.02 dB
SUM	±0.08 dB	±0.08 dB	±0.09 dB
RSS	±0.063 dB	±0.063 dB	±0.057 dB

Table II NOISE FIGURE AND GAIN UNCERTAINTIES

Table III shows the results of application of these conditions to Equation (3) for both smoothing conditions in terms of RSS and a summation.

Considering the magnitude of the allowable zero drift as shown in Table III, it is extremely surprising that the actual observed zero instability of the 2075 is much less. Even with minimum smoothing it seldom exceeds ±0.75 dB under these conditions. This is a credit to the very high stability of the RF input network of the instrument and the circuit designers who made it so.

Microwave Configurations

The two microwave amplifier DUT configurations available in the 2075 are 1.2 (swept LO) and 1.3 (swept IF). These will produce similar results, and so are considered together. The difference between single or double sideband measurements is essentially in the magnitude of the second stage noise figure, with single sideband generally being higher. Figure 5 is a block diagram of the measurement configurations.

The performance of the microwave configurations with respect to zero stability is degraded by the frequency and amplitude instabilities of the local oscillator, and the noise performance stability of the mixer. In addition, the second stage (measurement system) noise figure is generally much higher than in Configuration 1.1.

By itself, a higher noise figure will be manifested by a larger range of Y-factor jitter.

For now, ignore the additional degrading effects and lump them all into an increased second stage noise figure, using the same "delta" magnitudes as we did for Configuration 1.1 previously. This results in a range of allowable zero instability which can be plotted versus second stage noise figure. Figure 6 shows this plot. Note that these curves are calculated using the conservative estimates of random noise jitter used above for the simpler configuration.

Conclusions

From a theoretical standpoint, the 2075 should read zero after the second stage calibration and before the DUT is inserted in the setup—**only** for amplifier configurations 1.1, 1.2 and 1.3.

The characteristics of the random noise signal and the random instabilities in the ENR of the noise source will cause the zero indication to jitter and drift about zero. The allowable magnitude of the random zero instability can be estimated from Figure 6. This is an estimate because there was no consideration of LO or other equipment stability.

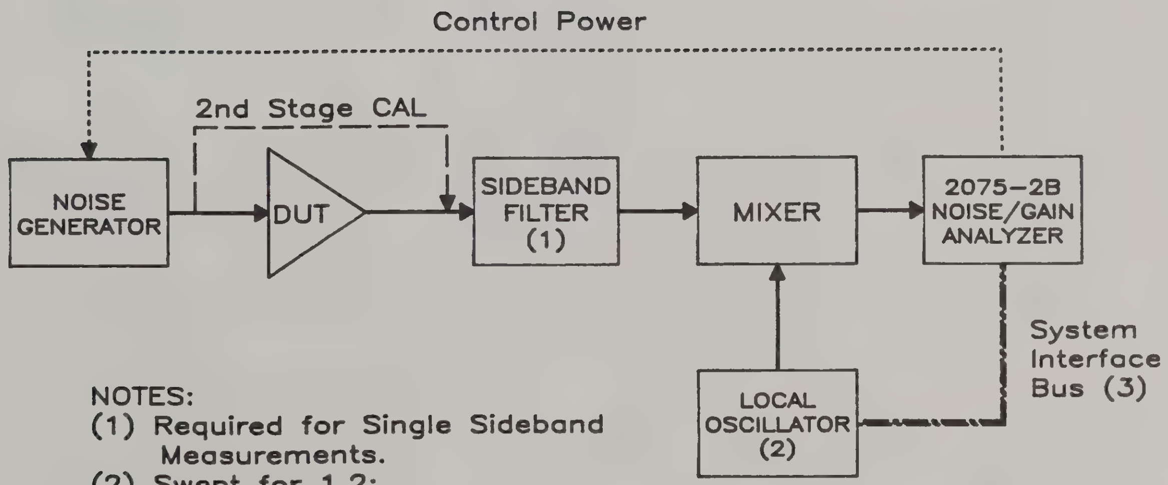
Because zero instability results primarily from random noise, it's magnitude can be reduced by increasing the smoothing factor.

Any errors or offsets that occur during or just after the second stage calibration process will result in a zero offset that can be calculated using the same developments outlined previously.

In general, the zero drift and stability of the 2075 is much better than the theoretical.

	MINIMUM SMOOTHING		MEDIAN SMOOTHING	
	SUM	RSS	SUM	RSS
$\Delta F_1'\big\|_{\Delta F_t'} = F_t \Delta F_t'$	0.95	0.86	0.40	0.32
$\Delta F_1'\big\|_{\Delta F_2'} = F_2 \Delta F_2'$	0.95	0.86	0.40	0.32
$\Delta F_1'\big\|_{\Delta G_1'} = (F_2 - 1)\Delta G_1'$	0.76	0.61	0.36	0.23
$\Delta F_1'\big\|_{\text{"0 dB"}}$	±2.66	±1.36	±1.16	±0.51

Table III "0 dB" UNCERTAINTY



NOTES:
(1) Required for Single Sideband Measurements.
(2) Swept for 1.2;
Fixed Tuned for 1.3.
(3) Optional for 1.3.

Figure 5 **DUT CONFIGURATIONS 1.2 AND 1.3**

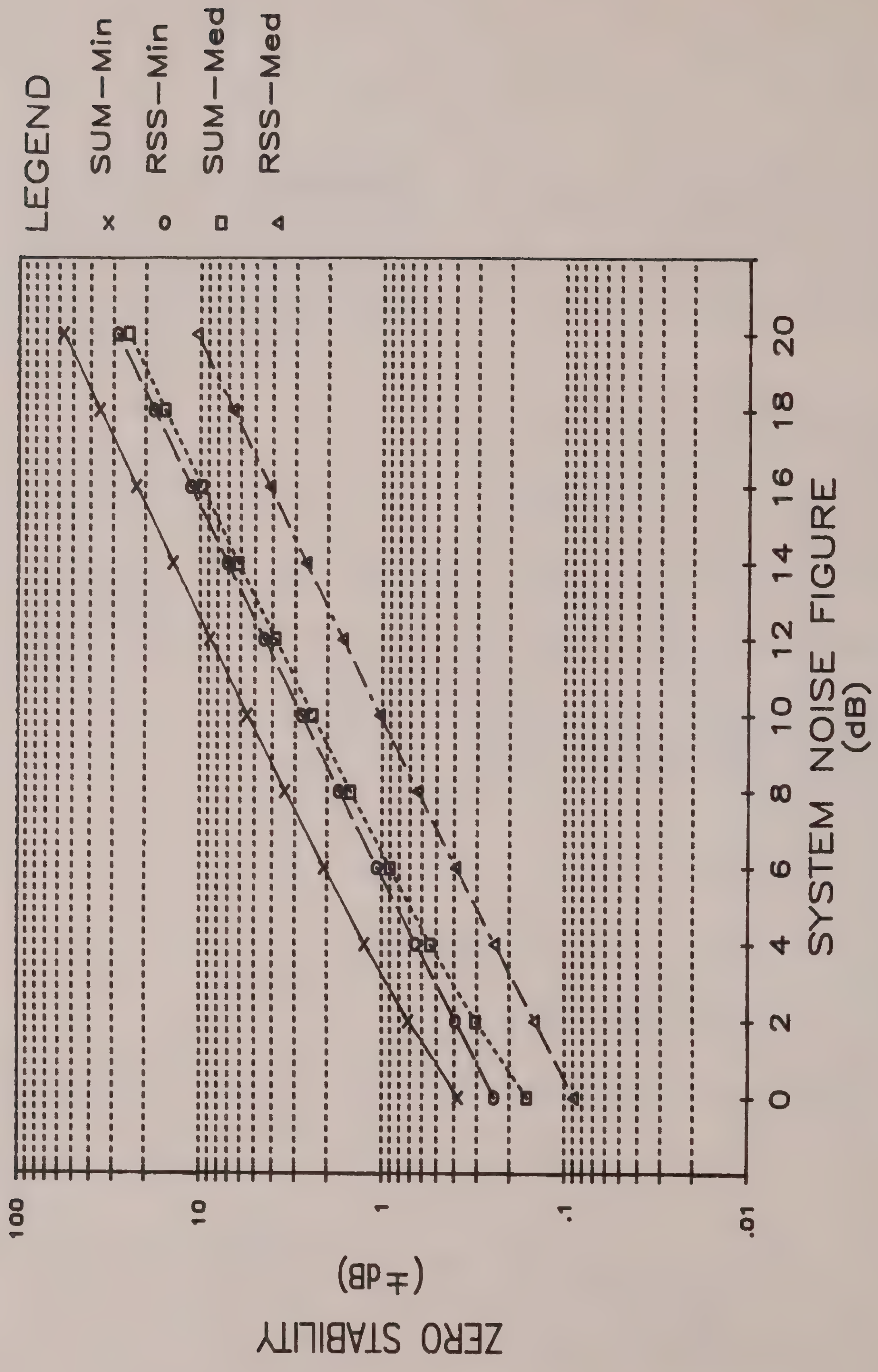


Figure 6 **ZERO STABILITY VERSUS SYSTEM NOISE FIGURE**

DERIVATION OF dB UNCERTAINTY IN TERMS OF FRACTIONAL UNCERTAINTY

Given a quantity, A', expressed in dB:

$$A' = 10 \text{ LOG}_{10} A$$

then, from the definition of logarithims:

$$A = 10^{(A'/10)}$$

and,

$$\text{LOG}_e A = A' \frac{\text{LOG}_e 10}{10} \approx \frac{1}{4.34} A'$$

Taking the differential on both sides and rearranging:

$$\boxed{\Delta A' = 4.34 \frac{\Delta A}{A}}$$

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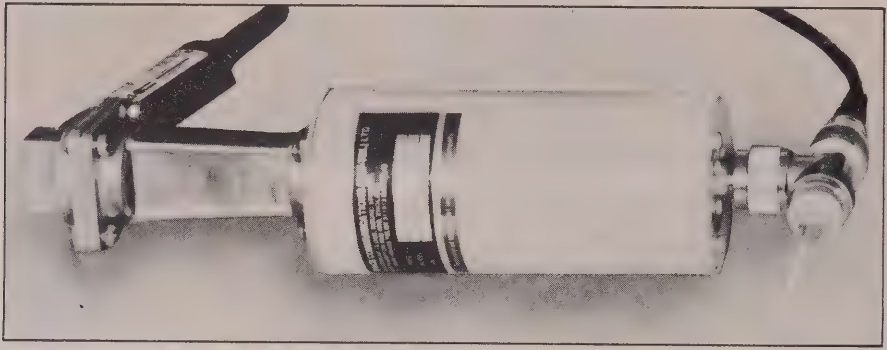


Figure 1. Typical LNB.

The importance of frequency response and sensitivity in satellite television receiver systems cannot be understated. This becomes even more critical as receiving antenna dishes become smaller or satellite radiated powers are reduced.

The normal parameters stated by DBS manufacturers to define passband and sensitivity are Noise Figure, Gain, Operating Frequency and Gain Flatness.

For TVRO/DBS the frequency band is an 800 MHz channel within the range 10.95 to 12.5 GHz. Typical noise figures can be expected between 2 and 3 dB with gains of 50 dB or more for RF to IF conversion and gain flatness of ±2 dB over the operating frequency range.

The most significant system component is the Low Noise Block (LNB) shown in figure 1. This consists of a Low Noise Amplifier (LNA) and a Low Noise Converter (LNC). The LNB has the greatest effect on system noise and gain and mounts directly on to the front of the antenna giving an IF output in the range 950 to 1750 MHz. This IF output is then fed along coaxial cable to the receiver where it is converted down to baseband video. See figure 2.

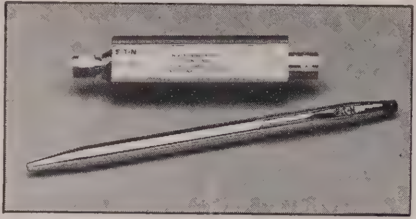


Figure 3a. Eaton 7618E Solid State Noise Source 10 MHz to 18 GHz.

Traditional methods of measuring frequency response and gain entailed the use of expensive and cumbersome sweep oscillators and scalar network analysers.

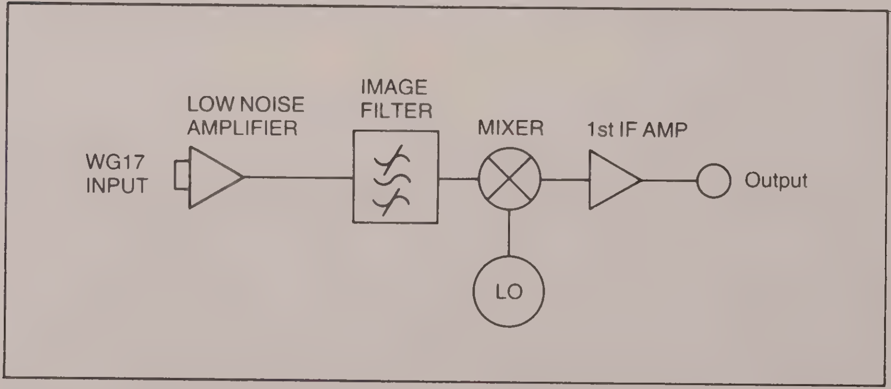


Figure 2. Circuit details of Low Noise Block.

Measurement of sensitivity or noise figure required even more specialised equipment.

Often the measurement of noise figure showed up problems which could not be detected by a scalar network analyser.

This article describes how frequency response and sensitivity can be measured simply using the Eaton 2075 Noise-Gain Analyser, a miniature noise generator and a general purpose oscilloscope.

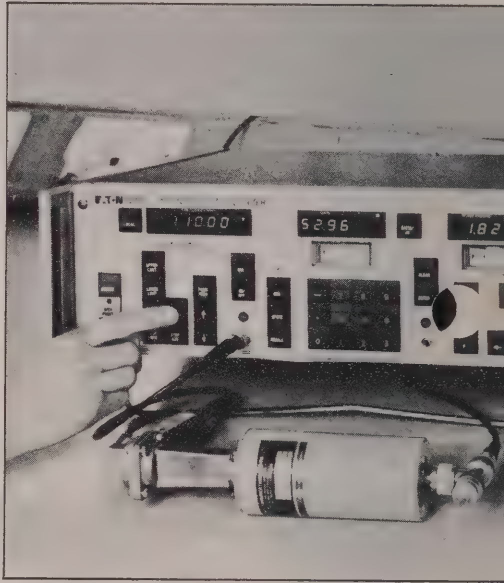


Figure 3. The complete measurement set-up with the no being injected into the front end via an adaptor. This adap the 2075. Being displayed is a noise figure of 1.82 dB ar

PASSBAND MEASUREMENTS USING A NOISE-GAIN ANALYSER

The Eaton 2075-2A Noise-Gain Analyser has a direct input frequency range of 10 MHz to 1900 MHz, making it ideally suited to the DBS IF frequency range, and will perform swept frequency and noise figure measurements, displaying the results on digital indicators. It will also display the gain and noise passband on a general purpose oscilloscope, allowing an instant check of the frequency response. See figure 4.

MAKING A MEASUREMENT

In order to make the measurement, a minimum of equipment is required:

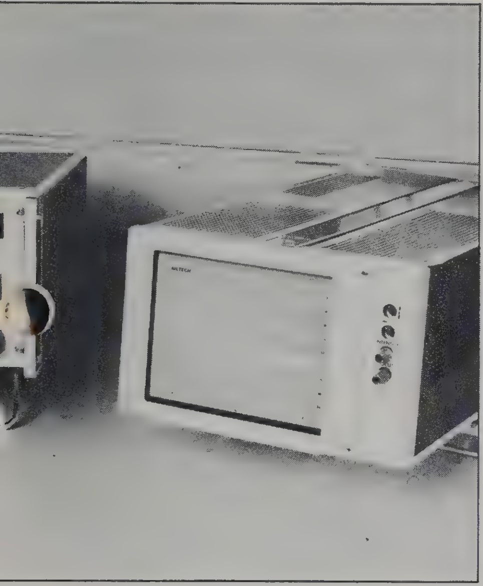
Eaton 2075-2A Noise-Gain Analyser.

Eaton 7618E Solid State Noise Source 10 MHz to 18 GHz.

A waveguide to coax adaptor WG17 to SMA.

A general purpose oscilloscope.

The equipment set up is shown in figure 5.



gain traces being displayed simultaneously. Noise is an insertion loss of 2 dB and this has been entered into n of 52.96 dB at a frequency of 11000 MHz.

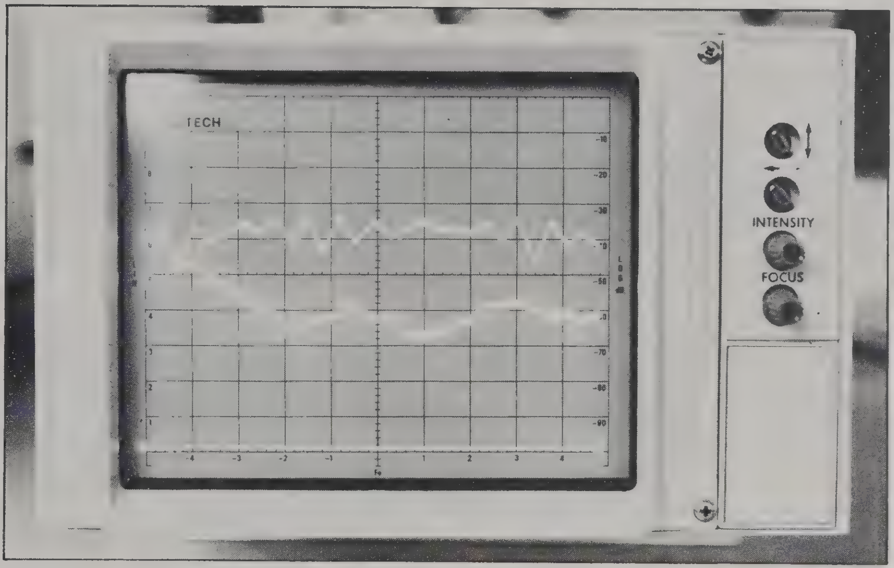


Figure 4. *Gain (top) and noise traces on an oscilloscope driven by the 2075.*

The measurement procedure is very straightforward. The desired measurement frequency range is entered directly into the 2075 along with the required step size. The frequency of the LNB's local oscillator is entered. The 2075 frequency sweep can then be initiated. It will perform repetitive sweeps within a desired range displaying the passband and noise on the oscilloscope. See figure 6 and 6a. Simultaneously, the numerical values of gain and noise figure are displayed on the instrument front panel, at the discrete frequency steps. Any losses that may be incurred in the system can also be entered into the 2075 and these will be taken into account.

The 2075 has a calibration procedure where the contributions from the second stage (ie the 2075 itself) are measured over the frequency range and stored in memory. These are then taken into account and corrected measurements are displayed.

The noise contribution from the image channel is not a problem due to the design of the LNB which already has an inbuilt image filter so upper single sideband measurements are always performed.

The 2075 also has front panel analogue meters which enable accurate tuning adjustments to be made more conveniently than with digital indicators alone.

If it is desired to read noise temperature (in Kelvins) rather than noise figure, the 2075 has a function which enables the noise temperature to be displayed directly in Kelvins.

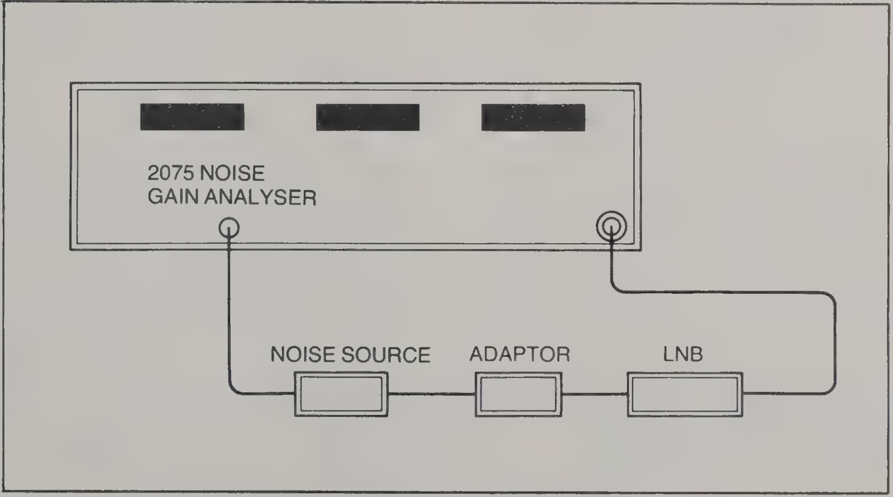


Figure 5. *Straightforward set-up for gain and noise figure measurement.*

ANTENNA NOISE TEMPERATURE

Antenna noise temperature can also be measured with the 2075. The method requires the use of a coupler and is configured as shown in figure 6.

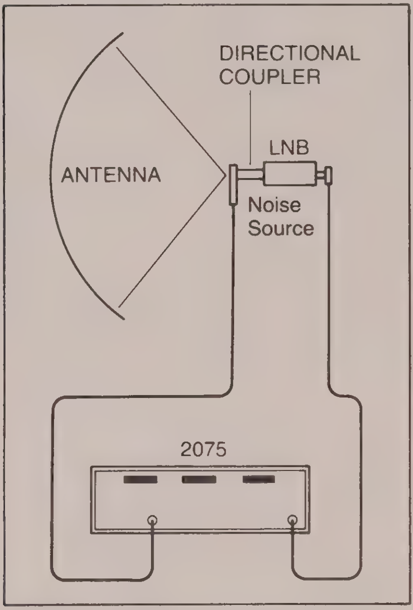


Figure 6. Antenna noise temperature measurement.

The Unit is first calibrated with a 50 ohm termination in place of the antenna. The antenna is then replaced and the noise temperature read from the 2075. A similar arrangement can be used to measure the overall noise temperature of the receiving system (T_{op}).

NOISE FIGURE THEORY

The normal procedure for noise figure measurement is the Y-factor method. This is performed by alternately connecting two known source noise temperatures to the input of the device under test and measuring the ratio of the resultant noise powers at the DUT output. This output ratio, known as the Y-factor, can be expressed as follows:

$$Y = \frac{T_H + (F-1)\,T_O}{T_C + (F-1)\,T_O}$$

Where:

T_H = The hot source temperature

T_C = The cold source temperature

T_O = The standard reference temperature (290K)

$F = \frac{N_{SO} + N_I}{N_{SO}}$

N_{SO} = Noise power available from the source termination at 290K

N_I = Noise power generated within the DUT.

This leads to the equation for noise figure expressed as a ratio:-

$$F = \frac{\frac{T_H}{T_O} - Y\,\frac{T_C}{T_O}}{Y-1} + 1$$

For most applications where T_C is equal to room temperature and therefore, to T_O the expression can be simplified to:

$$F = \frac{\frac{T_H}{T_O} - 1}{Y-1}$$

The numerator is a function of the noise source and is called the excess noise ratio (ENR) expressed in dB.

Therefore:

$$F_{dB} = ENR_{dB} - 10\log(Y-1)$$

Noise Sources are calibrated and supplied with a table of ENR values at specific frequencies throughout the range. These values are stored in the 2075, which has a microprocessor dedicated to performing the noise and gain calculations.

The gain is found from the ratio of the two measured noise powers after calibration has been performed.

The second stage noise contribution is corrected by the 2075 and is as follows:-

$$F\ \text{total} = F_1 + \frac{F_2 - 1}{G_1}$$

where F_2 is the second stage contribution and G_1 is the gain of the first stage. It can be seen that the greater the gain of the first stage the less significant the second stage contribution becomes.

SUMMARY

The Eaton 2075-2A is an extremely versatile instrument capable of performing many microwave measurements to a high degree of accuracy and much more economically than assembling a complex swept measurement system. The frequency range of the 2075 makes it ideal for checking DBS amplifiers, downconverters and antennas. Other applications include measurement of loss of passive components including attenuators, mixers, cables etc. The 2075 is also used for UHF TV tuner and VHF receiver testing.

The instrument is fully GPIB compatible and can control any IEEE 488 Sweep Oscillator enabling the input frequency range to be extended up to 65 GHz.

The unit is fully supported with the widest range of ancillary units available from a single manufacturer and the most comprehensive applications and field support facilities.

EATON

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Electronic Instrumentation Division
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213/822-3061

Printed in USA

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23100-8/87

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EATON

Revision 1, 12/3/85

Bulletin

2075 USER-DEFINED CONTROL PROGRAM FOR THE HP 8340

When using the Hewlett Packard 8340 Synthesized Sweeper as a local oscillator in Measurement Configurations 1.2 (microwave amplifier, swept L.O.), 1.4 (receiver, swept L.O.), or 1.6 (dual conversion, swept 2nd L.O.), the following steps are necessary to permit the 2075 to act as a bus controller for the 8340.

General Procedure

A. Set the 2075 to the user-defined control program entry mode (Special Function 48.1).

B. Enter the decimal equivalents of the ASCII characters that define the frequency prefix of the signal generator.

C. Enter the decimal equivalent of the ASCII character "CTRL-F".

D. Enter the decimal equivalents of the ASCII characters that define the frequency terminator of the signal generator.

E. Enter the decimal equivalents of the ASCII characters that define the output power prefix of the signal generator.

F. Enter the decimal equivalent of the ASCII character "CTRL-A".

G. Enter the decimal equivalents of the ASCII characters that define the output power terminator of the signal generator.

H. Enter the decimal equivalents of the ASCII characters that disable all modulation and marker functions in the signal generator.

I. Terminate the entry sequence.

J. Select the user-defined control program (Special Function 47.4).

K. Set the 2075 to the GPIB controller mode.

Detailed Procedure

In the detailed procedure for the HP 8340 shown below, the following abbreviations are used:

SPF is the 2075 "SPECIAL FUNCTION" key (SPEC FUNCT).
E is the 2075 "ENTER" key.

Note that if amplitude, and pulse modulation, and the frequency markers are manually disabled from the front panel of the 8340

prior to establishing the 2075 as the controller (step 10), Steps 4 through 6 can be deleted.

1. Establish the user-defined control program entry sequence.

   Depress: SPF 48.1 E

2. Enter the frequency control codes.

2a. Enter the decimal equivalent of the ASCII character "C".

   Depress: 67 E

2b. Enter the decimal equivalent of the ASCII character "W".

   Depress: 87 E

2c. Enter the decimal equivalent of the ASCII character "CTRL-F".

   Depress: 6 E

2d. Enter the decimal equivalent of the ASCII character "M".

   Depress: 77 E

2e. Enter the decimal equivalent of the ASCII character "Z".

   Depress: 90 E

3. Enter the power level control codes.

3a. Enter the decimal equivalent of the ASCII character "P".

   Depress: 80 E

3b. Enter the decimal equivalent of the ASCII character "L".

   Depress: 76 E

3c. Enter the decimal equivalent of the ASCII character "CTRL-A".

   Depress: 1 E

3d. Enter the decimal equivalent of the ASCII character "D".

   Depress: 68 E

3e. Enter the decimal equivalent of the ASCII character "B".

   Depress: 66 E

4. Enter the control codes to disable amplitude modulation.

4a. Enter the decimal equivalent of the ASCII character "A".

   Depress: 65 E

4b. Enter the decimal equivalent of the ASCII character "M".

Depress: 77 E

4c. Enter the decimal equivalent of the ASCII character "48".

Depress: 48 E

5. Enter the control codes to disable pulse modulation.

5a. Enter the decimal equivalent of the ASCII character "P".

Depress: 80 E

5b. Enter the decimal equivalent of the ASCII character "M".

Depress: 77 E

5c. Enter the decimal equivalent of the ASCII character "48".

Depress: 48 E

6. Enter the control codes to disable the frequency markers.

6a. Enter the decimal equivalent of the ASCII character "S".

Depress: 83 E

6b. Enter the decimal equivalent of the ASCII character "H".

Depress: 72 E

6c. Enter the decimal equivalent of ASCII character "M".

Depress: 77 E

6d. Enter the decimal equivalent of ASCII character "48".

Depress: 48 E

7. Terminate the entry sequence.

Depress: E

8. Select the user-defined program.

Depress: SPF 47.4 E

9. Set the 2075 to the controller mode.

Depress: SPF 40.2 E

EATON

Bulletin

075 USER-DEFINED CONTROL PROGRAM FOR THE HP 8673

When using the Hewlett Packard 8673 Synthesized Signal Generator as a local oscillator in Measurement Configurations 1.2 (microwave amplifier, swept L.O.), 1.4 (receiver, swept L.O.), or 1.6 (dual conversion, swept 2nd L.O.), the following steps are necessary to permit the 2075 to act as a bus controller for the 8673.

General Procedure

A. Set the 2075 to the user-defined control program entry mode (Special Function 48.1).

B. Enter the decimal equivalents of the ASCII characters that define the frequency prefix of the signal generator.

C. Enter the decimal equivalent of the ASCII character "CTRL-F".

D. Enter the decimal equivalents of the ASCII characters that define the frequency terminator of the signal generator.

E. Enter the decimal equivalents of the ASCII characters that define the output power prefix of the signal generator.

F. Enter the decimal equivalent of the ASCII character "CTRL-A".

G. Enter the decimal equivalents of the ASCII characters that define the output power terminator of the signal generator.

H. Enter the decimal equivalents of the ASCII characters that disable all modulation and marker functions in the signal generator.

I. Terminate the entry sequence.

J. Select the user-defined control program (Special Function 47.4).

K. Set the 2075 to the GPIB controller mode.

Detailed Procedure

In the detailed procedure for the HP 8673 shown below, the following abbreviations are used:

SPF is the 2075 "SPECIAL FUNCTION" key (SPEC FUNCT).
E is the 2075 "ENTER" key.

Note that if amplitude, frequency, and pulse modulation, and the frequency markers are manually disabled from the front panel of the 673 prior to establishing the 2075 as the controller (step 10), Steps 4 through 7 can be deleted .

1. Establish the user-defined control program entry sequence.

Depress: SPF 48.1 E

2. Enter the frquency control codes.

2a. Enter the decimal equivalent of the ASCII character "F".

Depress: 70 E

2b. Enter the decimal equivalent of the ASCII character "R".

Depress: 82 E

2c. Enter the decimal equivalent of the ASCII character "CTRL-F".

Depress: 6 E

2d. Enter the decimal equivalent of the ASCII character "M".

Depress: 77 E

2e. Enter the decimal equivalent of the ASCII character "Z".

Depress: 90 E

3. Enter the power level control codes.

3[illegible] Enter the decimal equivalent of the ASCII character "P".

Depress: 80 E

3b. Enter the decimal equivalent of the ASCII character "L".

Depress: 76 E

3c. Enter the decimal equivalent of the ASCII character "CTRL-A".

Depress: 1 E

3d. Enter the decimal equivalent of the ASCII character "D".

Depress: 68 E

3e. Enter the decimal equivalent of the ASCII character "M".

Depress: 77 E

4. Enter the control codes to disable amplitude modulation.

4a. Enter the decimal equivalent of the ASCII character "A".

Depress: 65 E

4b. Enter the decimal equivalent of the ASCII character "O".

Depress: 79 E

5. Enter the control codes to disable frequency modulation.

5a. Enter the decimal equivalent of the ASCII character "D".

Depress: 68 E

5b. Enter the decimal equivalent of the ASCII character "O".

Depress: 79 E

6. Enter the control codes to disable pulse modulation.

6a. Enter the decimal equivalent of the ASCII character "P".

Depress: 80 E

6b. Enter the decimal equivalent of the ASCII character "O".

Depress: 79 E

7. Enter the control codes to disable the frequency markers.

7a. Enter the decimal equivalent of the ASCII character "M".

Depress: 77 E

. Enter the decimal equivalent of the ASCII character "O".

Depress: 79 E

8. Terminate the entry sequence.

Depress: E

9. Select the user-defined program.

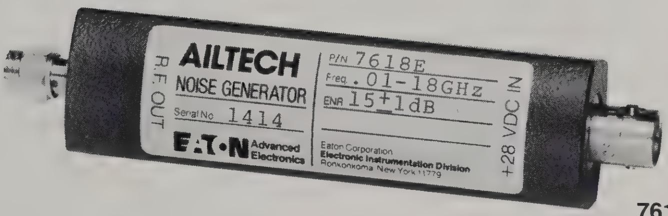
Depress: SPF 47.4 E

10. Set the 2075 to the controller mode.

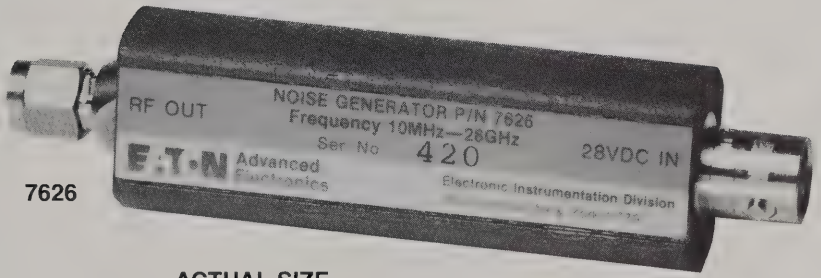
Depress: SPF 40.2 E

Ailtech

Solid State Noise Generators
7618E 10MHz to 18GHz
7626 10MHz to 26GHz



7618E



7626

ACTUAL SIZE

A Major Improvement in Cost Effectiveness and Measurement Convenience in Noise Figure Measurement Systems

EATON

Cost Effective
Convenient
Accurate
Precise

Cost Effective

10MHz to 26GHz in a single, precise, accurate, solid-state noise generator (18GHz for the 7618E). If your noise figure measurement needs cover several traditional frequency bands, you can save thousands of dollars over past conventional solid-state offerings with one of these broadband generators.

Moreover, if your application extends above 18GHz (the traditional upper limit of laboratory solid-state noise generators), you can dispense with fragile, gas-discharge, waveguide noise sources and their expensive, high voltage power supplies.

Convenient

Regardless of whether your application is component or subassembly testing (amplifiers, mixers, transistors, GaAsFETSs, etc.) or measurement of complete receiver systems, the 7618E or 7626 is probably the only noise generator you will ever need.

Consider, for example, the measurement problems associated with a modern, satellite communications system with an intermediate frequency of 140MHz, an up link frequency in the 15 to 18GHz band and a down link frequency in the 19 to 21GHz band. In the past, one solid-state noise generator would be required for the I.F. measurement, another for the up link, and a waveguide, gas-discharge generator (probably with accuracy-degrading waveguide to coaxial adapters) for the down link measurements. In addition, the gas-discharge noise generator, besides being cumbersome and rather fragile, requires a special power source.

A single, AILTECH 7626 is the only noise generator required for this application. Moreover, the 7626, with its precision, male SMA output connector, eliminates the need for adapters in most cases.

Accurate

±0.25 dB *WORST CASE* uncertainty at 18GHz. EATON always quotes worst case; thus, you, the user, can have absolute confidence that your measurements are within a specific range rather than the uncertainty of wondering whether or not your particular noise generator is actually outside its root-sum-squares specified tolerance.

An absolute knowledge of noise generator excess noise ratio (ENR) tolerance can save you hours tracking down measurement error sources and correlation discrepancies between engineering and production test, incoming inspection, and vendor, etc.

Every AILTECH noise generator is calibrated using the AILTECH Model 82 Noise Calibration System.* At applicable frequencies, the calibration of EATON's noise standards is directly traceable to the National Bureau of Standards (NBS). At other frequencies, calibration is traceable to the Electronic Quality Assurance Directorate, Aguila, Bromley, England, and cross-checked against thermal noise standards.

The worst-case, excess noise ratio (ENR) uncertainties at each calibration frequency are tabulated under "Specifications" of this brochure on the last page. The uncertainties listed are standard production values. At some frequencies, EATON can provide a precision calibration (at additional cost) and offer even better accuracy (e.g.: ±0.15dB at 18GHz). Consult the factory for details.

and More

The unusually broad frequency coverage of the 7618E and the 7626 results in time and money savings, but the major characteristic of a noise generator is accuracy.

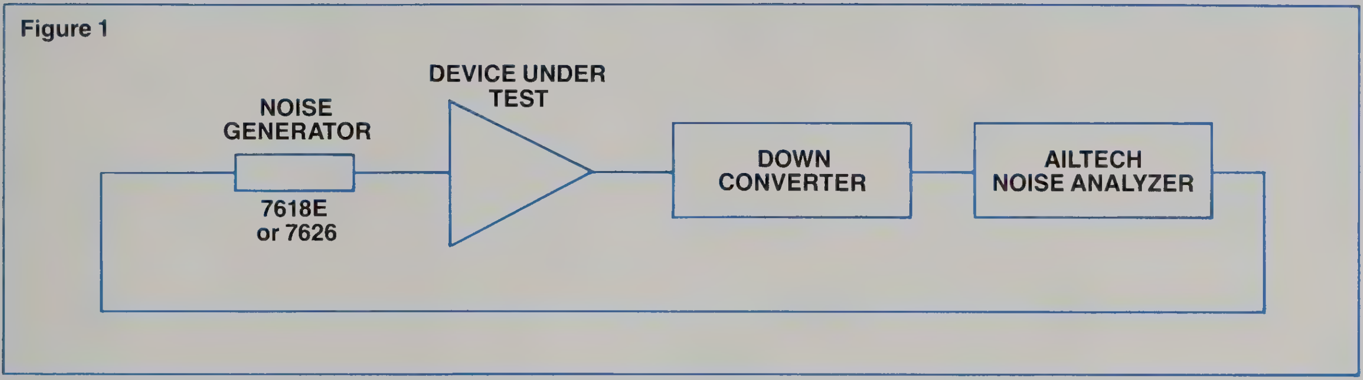
An analysis of a noise figure measurement set-up will show that noise generator accuracy is the major contributor to the overall measurement uncertainty. Recognizing this, EATON provides ENR calibration points every GHz above 1GHz as well as at 30, 100, 300 and 1500MHz. The worst-case calibration accuracies of the 7618E and the 7626 are shown in table A.

The accuracy of a noise figure measurement using standard techniques (see figure 1 for an illustration of a typical set-up) can also be affected by the source mismatch seen by the input of the device-under-test. The noise figure of a device can change if the source impedance varies. Since the noise generator assumes two conditions during the measurement (on and off), this could add a further uncertainty to the results. The low SWR of AILTECH noise generators in both the on and off condition reduces this uncertainty, further improving measurement accuracy. Maintaining a low SWR is important because source mismatch effects on noise figure measurement accuracy have never been completely analyzed. The excellent mismatch performance of the 7618E and 7626 are illustrated in figures 2, 3 and 4.

---

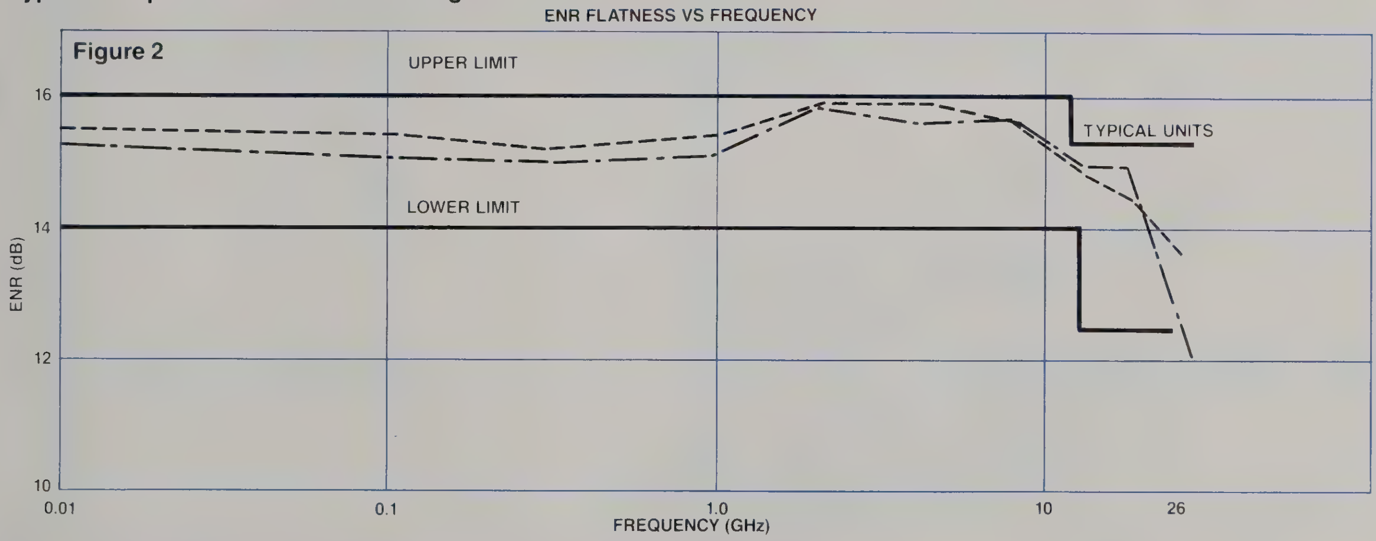
*This system was reviewed by the National Bureau of Standards in 1968 (NBS Report #9729 "Error Analysis of the AIL Noise Measuring System," W. C. Daywitt, Sept. 1968). Copies of this report are available from EATON Corporation, Electronic Instrumentation Division, upon request.

Figure 1



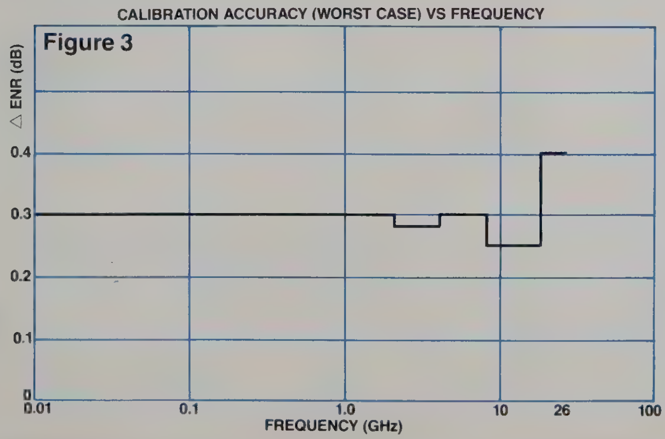
Typical Setup Used to Measure Noise Figure

Figure 2



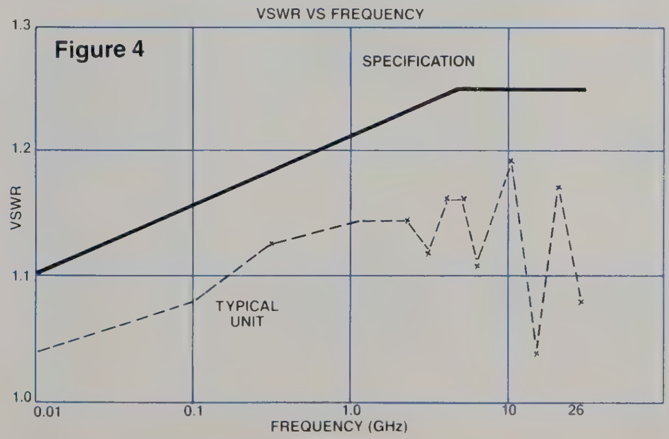
Plot of Excess Noise Ratio vs Frequency of a Typical 7626 Solid State Noise Generator

Figure 3



Calibration Accuracy of the 7618E and 7626 Noise Generators

Figure 4



VSWR of the 7626 Noise Generator

Specifications

	7618E	7618EN	7618EL	7618ELN	7626
Frequency Range	.01–18 GHz	.01–18 GHz	.01–18 GHz	.01–18 GHz	.01–26.5 GHz
Excess Noise Ratio	15 dB	15 dB	6 dB	6 dB	15 dB, .01–12.4 GHz 14 dB, 12.4–26.5 GHz
ENR Flatness vs. Frequency	±1 dB	±1 dB	±1 dB	±1 dB	±1 dB, .01–12.4 GHz ±1.5 dB, 12.4–26.5 GHz
VSWR	1.2, .01–12.4 GHz 1.3, 12.4–18 GHz	1.34, .01–12.4 GHz 1.46, 12.4–18 GHz	1.2, .01–12.4 GHz 1.3, 12.4–18 GHz	1.34, .01–12.4 GHz 1.46, 12.4–18 GHz	1.25, or 1.1 + .02f (GHz), whichever is smaller
Input Connector	BNC Female	BNC Female	BNC Female	BNC Female	BNC Female
Output Connector	Precision SMA Male	Type N Male	3 mm Male	Type N Male	Precision SMA Male
Size	4-1/4″	5-3/4″	4-5/8″	5-3/4″	3-1/2″
Weight	85 g	218 g	90 g	218 g	56.7 g

Notes: 1. Power required is +28V at less than 20 mA. 2. Maximum Reverse RF Power is 1 Watt.

Table A
ENR Accuracy:

Frequency (GHz)	Worst Case Uncertainty (dB)	Traceability*
0.03	0.30	EQD
0.3	0.30	EQD
1.0	0.30	EQD
2.0	0.30	EQD
3.0	0.28	NBS
4.0	0.28	NBS
5.0	0.30	H/C
6.0	0.30	EQD
7.0	0.30	EQD
8.2	0.25	NBS
9.0	0.25	NBS
10.0	0.25	NBS
11.0	0.25	NBS
12.0	0.25	NBS
13.0	0.25	NBS
14.0	0.25	NBS
15.0	0.25	NBS
16.0	0.25	NBS
17.0	0.25	NBS
18.0	0.25	NBS
19.0	0.40	G
20.0	0.40	G
21.0	0.40	G
22.0	0.40	G
23.0	0.40	G
24.0	0.40	G
25.0	0.40	G
26.0	0.40	G

Supplemental Characteristics

ENR Variation with Temperature:
<0.01dB/°C

ENR Variation with Voltage:
<0.1dB/%△V

Switching Speed:
<2µs

*EQD: Electronic Quality Assurance Directorate
H C: Thermal Noise Standard
NBS: U.S. National Bureau of Standards
G: Internal Gas Standard

Eaton Corporation
Electronic Instrumentation Division
5340 Alla Road
Los Angeles, California 90066
213/822-3061

13011-10/86

In the interest of product improvement, all specifications are subject to change without notice.

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HP 346A
346B, 346C

OPERATING AND SERVICE MANUAL

346A
346B
346C

NOISE SOURCE

(Including Options 001, 002, and 004)

HEWLETT
PACKARD

HP 346A
346B, 346C

346B-4

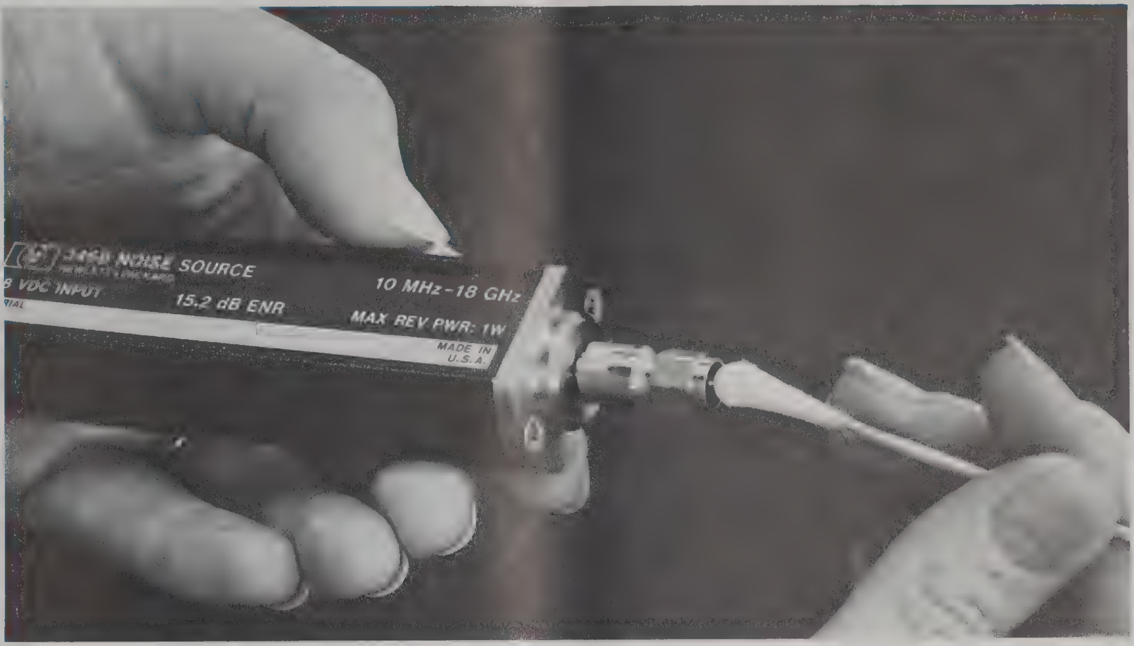
SERVICE NOTE

Supersedes:
None

HP 346B NOISE SOURCE

All Serials

RF CONNECTOR CARE



This note covers several major areas to help you preserve your connectors, save you money, and increase the accuracy and repeatability of your measurements.

GENERAL CONNECTOR CARE PRACTICES

1. Always tighten or loosen a connector by rotating only the nut. Never rotate the connector body when tightening or loosening. This applies to all connector types. Failure to observe this precaution can lead to unscrewing of the center conductor on Type-N connectors and severe damage of whatever the center conductor mates to on all types on connectors.
2. Cleanliness is very important; use pure isopropyl, ethyl alcohol or liquid freon on a swab to clean connectors. Cotton swabs may leave filaments of cotton in the connector so check for residue after using swabs; absorbent, lint-free paper wrapped around the end of tweezers is a better choice. Carefully clean the center conductor, outer conductor, dielectric and the surface where the outer conductors butt together. After cleaning, be sure the connector is blown dry before re-assembly. It is good practice to inspect the connector under magnification after cleaning to be sure all contaminants are removed and to check for wear. Never use acetone, methanol, denatured alcohol, or other solvents as they can damage the dielectric.

I/NS/WN

4/84-04/ST

HP 00346-90023

HEWLETT PACKARD

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Printed in U.S.A.

3. A small amount of dirt on the mating surfaces of APC-7® connectors can keep the outer conductor from making good contact.

4. A connector with worn plating on the inner or outer conductors should be replaced since there is a good possibility of loose, intermittent connections. If you can see the metal that underlies the plating, the connector is excessively worn. Intermittent problems with SWR variation and RF leakage can sometimes be observed even before the plating is worn all the way through.

5. Lateral forces applied to connectors should be minimized, otherwise distortion of the connector outer shell can result. This is especially important with SMA connectors. You can minimize lateral forces on a connector by supporting the cable or component attached to the connector.

6. If the center conductor fingers of APC-3.5 connectors spread apart, even a little bit, a power hole several dB deep can occur at about 22 GHz. This same thing can also happen to Type-N connectors with the power hole occurring at 12 GHz. This condition can be caused by several factors.

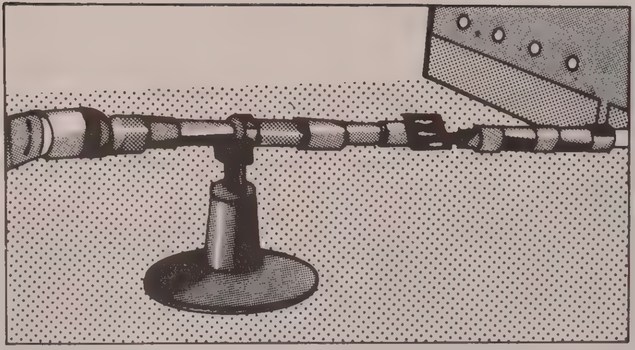
   (a) a misaligned center conductor on the male connector

   (b) rocking a cable to get it in or out, or

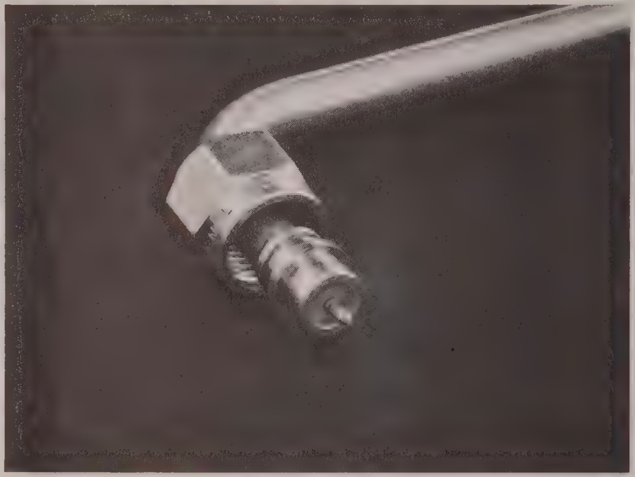
   (c) having the connector misaligned when tightening the nut. This is especially likely to occur when the connector is in tight quarters (such as inside equipment). Be sure connectors are axially aligned before the nut is tightened.

7. Center pin depth is critical on male and female connectors for SMA and APC-3.5. Basically, the center conductor shoulder should just reach the plane of the outer conductor mating surface and should not extend beyond it. The specifications are +0.000, −0.003 inches or 0.076 mm.

8. On SMA and APC-3.5 male connectors the outer nut retaining ring can be removed to facilitate the proper seating of the center conductor when used with semi-rigid cables. Otherwise, it is easy to drive the center pin into the dielectric, completely missing the female center pin.



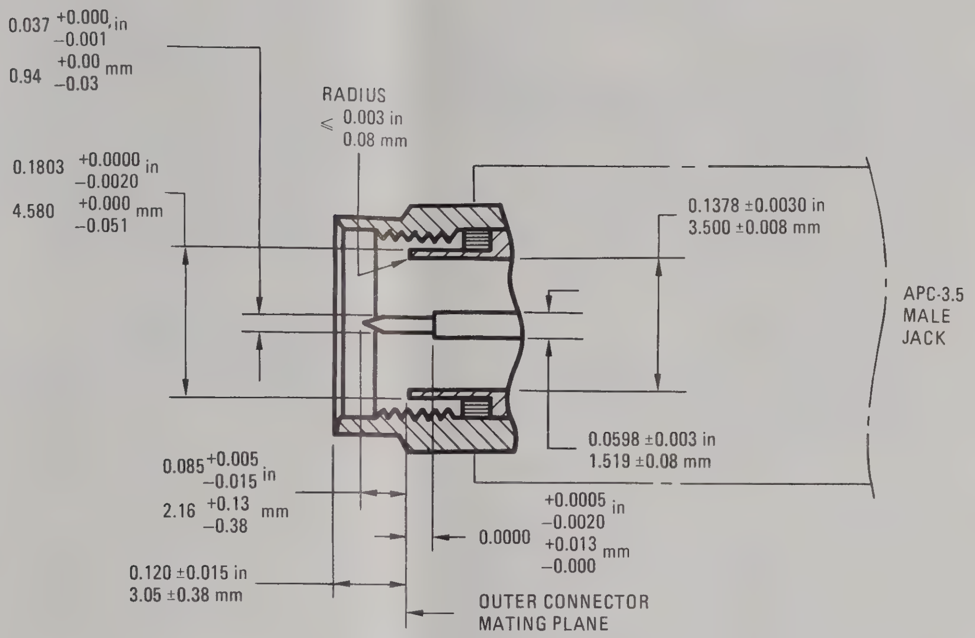
Minimize lateral force by bracing.

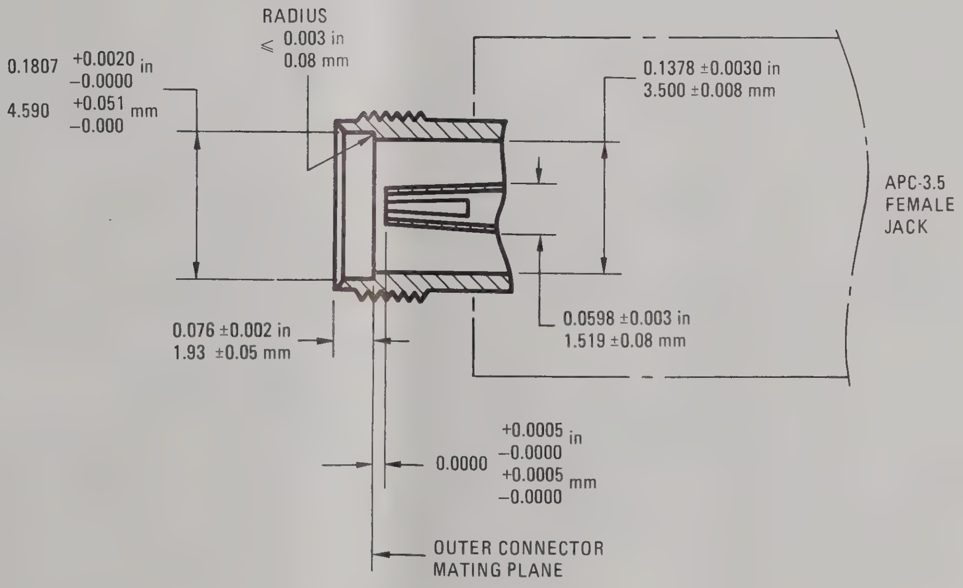


Remove outer nut retaining ring to make center conductor seating easier.

Tighten only one APC-7 nut. The other one should spin freely.

APC-7® is U.S. registered trademark of the Bunker Ramo Corporation.





APC-3.5 Connector Dimensions

3. A small amount of dirt on the mating surfaces of APC-7® connectors can keep the outer conductor from making good contact.

4. A connector with worn plating on the inner or outer conductors should be replaced since there is a good possibility of loose, intermittent connections. If you can see the metal that underlies the plating, the connector is excessively worn. Intermittent problems with SWR variation and RF leakage can sometimes be observed even before the plating is worn all the way through.

5. Lateral forces applied to connectors should be minimized, otherwise distortion of the connector outer shell can result. This is especially important with SMA connectors. You can minimize lateral forces on a connector by supporting the cable or component attached to the connector.

6. If the center conductor fingers of APC-3.5 connectors spread apart, even a little bit, a power hole several dB deep can occur at about 22 GHz. This same thing can also happen to Type-N connectors with the power hole occurring at 12 GHz. This condition can be caused by several factors.

   (a) a misaligned center conductor on the male connector

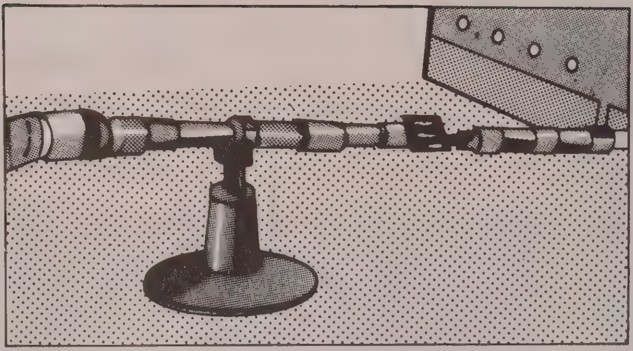
   (b) rocking a cable to get it in or out, or

   (c) having the connector misaligned when tightening the nut. This is especially likely to occur when the connector is in tight quarters (such as inside equipment). Be sure connectors are axially aligned before the nut is tightened.

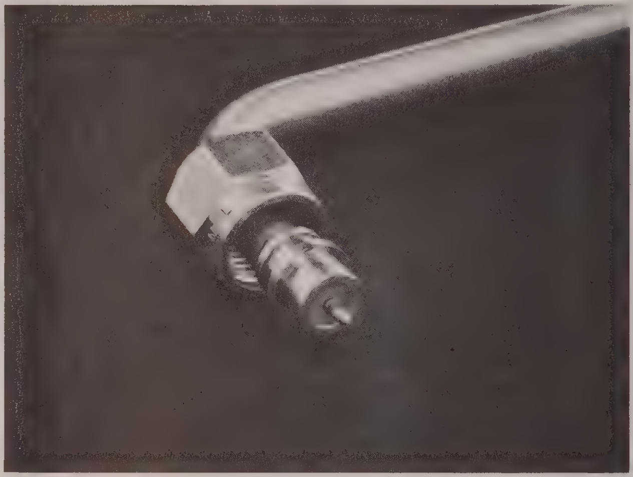
7. Center pin depth is critical on male and female connectors for SMA and APC-3.5. Basically, the center conductor shoulder should just reach the plane of the outer conductor mating surface and should not extend beyond it. The specifications are +0.000, −0.003 inches or 0.076 mm.

8. On SMA and APC-3.5 male connectors the outer nut retaining ring can be removed to facilitate the proper seating of the center conductor when used with semi-rigid cables. Otherwise, it is easy to drive the center pin into the dielectric, completely missing the female center pin.

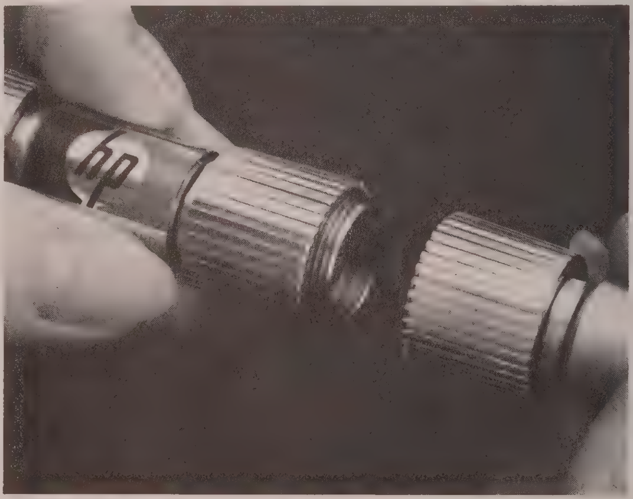
APC-7® is U.S. registered trademark of the Bunker Ramo Corporation.



Minimize lateral force by bracing.



Remove outer nut retaining ring to make center conductor seating easier.



Tighten only one APC-7 nut. The other one should spin freely.

9. When using APC-7 connectors, the nut of one connector should always be backed off completely and the nut on the mating connector should be tightened. Never tighten the nuts to one another. The center conductor collets are subject to wear and sometimes become deformed due to overtightening. Also, never set an APC-7 connector on its mating surface as you can damage both the inner and outer mating surfaces. Before storage, always screw the nut out to protect the surfaces or use a protective cap.

TORQUE LIMITS

Be careful not to overtighten any connector. A properly torqued connector will not leak excessively unless it is either damaged or dirty. Connections with low and repeatable SWR and attenuation require that the center conductors be properly positioned with one another. Type-N and APC-7 connectors should be tightened firmly to make sure there is good RF contact around the entire outer conductor.

Connector Type	Torque Specifications	Damage Level
N	12 in-lb (1.3 N·m)	25 in-lb (2.8 N·m)
APC-7	12 in-lb (1.3 N·m)	
SMA to SMA	5 in-lb (0.6 N·m)	10 in-lb (1.1 N·m)
SMA to APC-3.5	5 in-lb (0.6 N·m)	10 in-lb (1.1 N·m)
APC-3.5 to APC-3.5	8 in-lb (0.9 N·m)	

Remember, even when you observe these limits, a connector will not last forever but it will last a lot longer than if the limits are exceeded. HP sells torque wrenches. HP part number 5060-0343, 3/4" wrench for APC-7 nuts and 5060-0344, 9/16" wrench for the improved HP 346B APC-3.5 nut.

1. Use an extender-adapter to save difficult-to-replace connectors. That way you only have to replace the adapter when it wears out.

Connector	HP Part Number
N	1250-0597
APC-7	NA
SMA	1250-1681 or -1758 or -1462 or -1605
APC-3.5	NA

2. Throw away damaged connectors. They will damage any good connectors that are attached to them. So, don't take any chances by leaving them around.

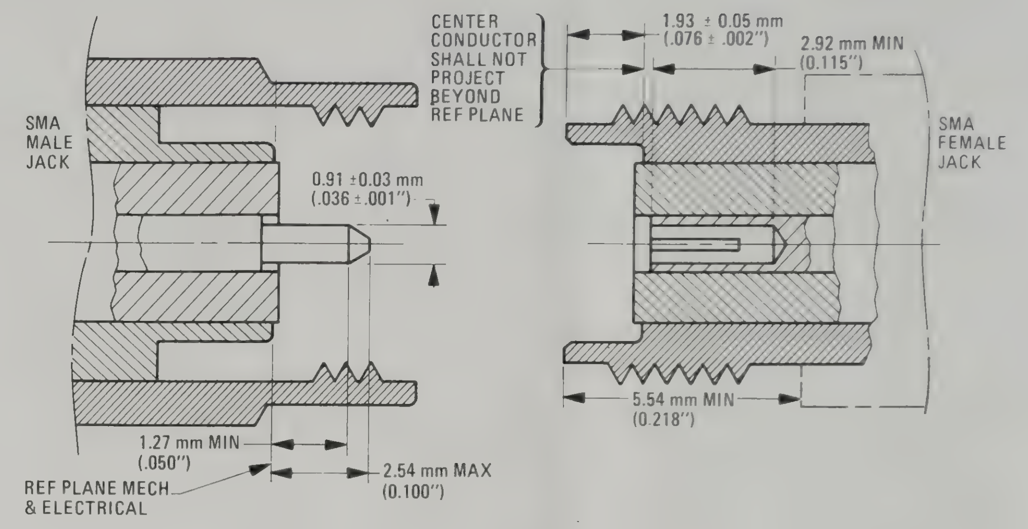
3. Some Type-N and APC-3.5 female connectors have such strong retention force that they can pull the center pin of their mates out beyond the specification limits. Upon subsequent matings with other connectors, the male connector can cause considerable damage by pushing the female center conductor back too far.

4. Use a connector gauge before mating a connector to an expensive component. The cost of a gauge may prevent damaging the component. Gauges can be obtained from most connector manufacturers.

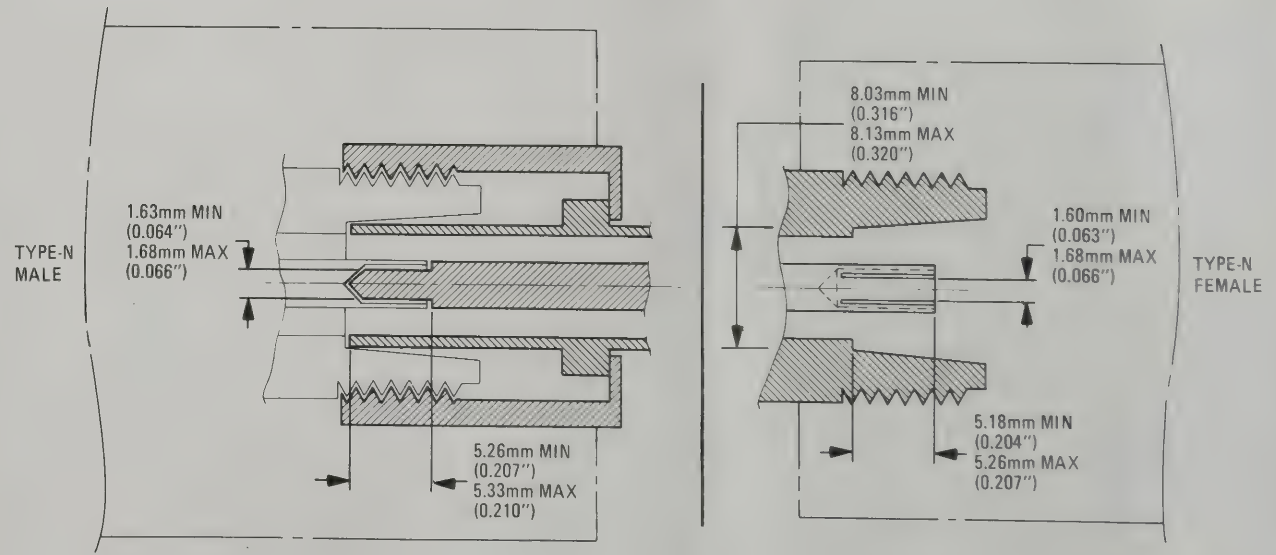
5. SMA connectors have a very limited number of connect and disconnect cycles before they show appreciable wear. This can be as low as 4 or 5 cycles; certainly no more than 100, even with great care. Generally speaking the SMA connector is not designed for use in environments where is will be frequently connected and disconnected.

6. APC-3.5 connectors last longer (maybe 1000 cycles), but this life can be shortened greatly by mating with SMA connectors. This is especially true for the APC-3.5 female connector being mated to an SMA male since the outer conductor of the SMA male is sharp and tends to wear the APC-3.5 mating surface rather quickly. Damage is aggravated by overtightening the connector or by rotating the connector body instead of the nut while tightening or loosening the connector. A worn SMA connector (such as on a mixer) can destroy a good APC-3.5 connector attached to it just once.

7. APC-3.5 connectors that are out of specifications can destroy the hermeticity of a mating connector or damage female center conductors and cause frequency response degradation. This can lead to very expensive repairs due to internal damage to an item that is designed to be sealed.


SMA MALE JACK
CENTER CONDUCTOR SHALL NOT PROJECT BEYOND REF PLANE
1.93 ± 0.05 mm (.076 ± .002")
2.92 mm MIN (0.115")
SMA FEMALE JACK
0.91 ±0.03 mm (.036 ±.001")
5.54 mm MIN (0.218")
1.27 mm MIN (.050")
REF PLANE MECH & ELECTRICAL
2.54 mm MAX (0.100")

SMA Connector Dimensions



Type-N Connector Dimensions

346A
346B
346C
NOISE SOURCE

(Including Options 001, 002, and 004)

SERIAL NUMBERS

This manual applies directly to instruments having the following serial number prefixes:

346A-2336A & 2614A
346B-2401A & 2614A
346C- 339A

With changes described in the MANUAL CHANGES appendix, this manual also applies to 346B Noise Sources prefixed 2330A and lower.

For additional important information about serial numbers, see INSTRUMENTS COVERED BY MANUAL.

HEWLETT
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Printed: NOVEMBER 1983

GENERAL INFORMATION

This manual contains operating and service information for the Hewlett-Packard Model 346A, 346B, and 346C Noise Sources. Included in the manual is information necessary to operate the Noise Sources. On the title page of this manual below the manual part number is a "microfiche" part number. This number may be used to order a 10 x 15 cm (4 x 6 inch) microfilm transparency of the manual.

Specifications

Instrument specifications are listed in Table 1. These specifications are the performance standards, or limits against which the instrument can be tested. Supplemental characteristics in Table 2 are not specifications but are typical characteristics included as additional information for the user.

Instruments Covered By Manual

The Noise Sources covered by this manual have a two part serial number. The first four digits and letter constitute the serial number prefix. The last five digits form a sequential suffix that is unique to each Noise Source. The prefix is the same for all Noise Sources of a particular configuration. It will

Table 1. Specifications

ENR accuracy: calibrations at cardinal frequencies are printed on each noise source and on a separate report shipped with each 346 Noise Source to the accuracy shown in the following table.

Frequency (GHz)	Worst Case Uncertainty (dB)	Root-Sum-of-Squares Uncertainty (dB)
0.01 to 7	0.30	0.09
8 to 10	0.27	0.09
11 to 12	0.28	0.09
13 to 18	0.30	0.11
19 to 20	0.40	0.15
21	0.50	0.19
22 to 23	0.58	0.21
24 to 26.5	0.67	0.30

Frequency range: 10 MHz to 18 GHz for 346A and 346B; 10 MHz to 26.5 GHz for 346C.

Excess noise ratio (ENR) range: calibrated values at cardinal frequencies printed on label. Range of value is 4.5 through 6.5 dB for 346A, 14 to 16 dB for 346B, and 12 to 16 dB (10 MHz to 12 GHz) and 14 to 17 dB (12 to 26.5 GHz) for 346C.

Maximum SWR (reflection coefficient) for source ON and source OFF (50 ohm reference impedance):
346A/B: 10 to 30 MHz — 1.3 (0.13)
30 to 5000 MHz — 1.15 (0.07)
5 to 18 GHz — 1.25 (0.11).
346C: 10 MHz to 18 GHz — 1.25 (0.11)
18 to 26.5 GHz — 1.35 (0.15).

Maximum change in complex reflection coefficient between source ON and source OFF at all frequencies for 346A only: 0.01.

Power required: 28 ± 1V.
346A/B: 60 mA peak, 30 mA average for source ON.
346C: 45 mA.

Operating temperature: 0 to 55° C.

Connectors: bias: BNC(f); noise output: APC-3.5(m)—also mates with female SMA connectors. See option information for other connector styles.

Maximum reverse power: 1W.

Dimensions: 140 x 21 x 31 mm (5.5 x 0.8 x 1.2 in.).

Net Weight: 0.1 kg (3.5 oz).

Table 2. Supplemental Characteristics

ENR variation with temperature: <0.01 dB/°C for 30 MHz to 26.5 GHz.

ENR variation with voltage: internal current regulator for <0.02 dB variation for 28 ±1V.

Switching speed: for repetitive operation (in previous state for less than 5 seconds), turn-on: <20 μs; turn-off: <80 μs. For single shot operation (in previous state more than 5 seconds), turn-on: <3 ms; turn-off: <80 μs.

Instruments Covered By Manual (cont'd)

change when a design modification occurs. The contents of this manual apply directly to those instruments having the same serial number prefixes listed under SERIAL NUMBERS on the title page.

A Noise Source manufactured after the printing of this manual may have a serial number prefix which is higher than the prefixes listed on the title page. This indicates that the Noise Source is different than those documented in this manual. The manual for these instruments is supplied with a yellow manual changes supplement that contains change information to document the differences. To keep this manual as current and accurate as possible, Hewlett-Packard suggests that you periodically request the latest copy of the MANUAL CHANGES supplement. Identify the supplement with the manual print date and part number, both of which appear on the title page. Complimentary copies of this supplement are available from Hewlett-Packard.

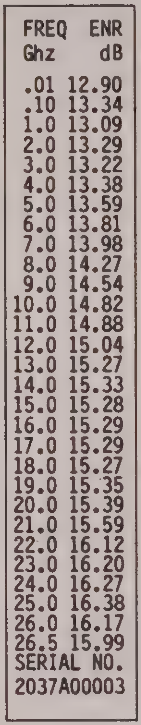
Model 346B Noise Sources which were manufactured before the printing of this manual will have a serial number prefix lower than the one listed on the title page. Manual changes for these older models are found in the appendix entitled MANUAL CHANGES at the back of this manual.

Description

The Noise Source produces noise output (power-on) when +28 V is applied. When it is off, there is residual noise due to thermal agitation in the Noise Source (power-off). These two noise levels are used to measure the gain and added noise of the device under test, and consequently, its noise figure.

The Excess Noise Ratio (ENR) for each Noise Source has been measured at major frequencies and recorded on a label attached to the Noise Source (see Figure 1). ENR references power-on to the noise power that exists at 290 Kelvins (17°C). In addition, a separate calibration sheet showing the complex reflection coefficient in both the on and off states is included with each instrument.

All 3 models are provided with a BNC female connector for power input. The output connector is a male APC-3.5 on the standard Noise Sources. Type-N and APC-7® connectors are available as options for the 346A and 346B Noise Sources. In addition to these general characteristics, certain characteristics apply to the specific models. These characteristics are listed in Table 3.



FREQ Ghz	ENR dB
.01	12.90
.10	13.34
1.0	13.09
2.0	13.29
3.0	13.22
4.0	13.38
5.0	13.59
6.0	13.81
7.0	13.98
8.0	14.27
9.0	14.54
10.0	14.82
11.0	14.88
12.0	15.04
13.0	15.27
14.0	15.33
15.0	15.28
16.0	15.29
17.0	15.29
18.0	15.27
19.0	15.35
20.0	15.39
21.0	15.59
22.0	16.12
23.0	16.20
24.0	16.27
25.0	16.38
26.0	16.17
26.5	15.99

SERIAL NO.
2037A00003

Figure 1. Typical Calibration Label

Table 3. Individual Noise Source Model Characteristics

346A	1. Reflection coefficient differential between on and off states is specified to be no greater than 0.01. 2. Specified output noise spectrum from 10 MHz to 18 GHz. 3. Nominal ENR is 6 dB over the specified frequency range.
346B	1. Reflection coefficient differential between on and off states is not specified, but is less than 0.1 typically. 2. Specified output noise spectrum from 10 MHz to 18 GHz. 3. Nominal ENR is 15 dB over the specified frequency range.
346C	1. Reflection coefficient differential between on and off states is not specified, but is less than 0.1 typically. 2. Specified output noise spectrum from 10 MHz to 26.5 GHz. 3. Nominal ENR is 15 dB over the specified frequency range.

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346A: 4. Not directly useable for HP 8970A IF attenuator calibration (Special Function 33).
10 dB of gain is required.

346B/C: 4. Suitable for HP 8970A IF attenuator calibration (Special Function 33).

Warranty

The Noise Sources are warranted and certified as indicated on the inside of the rear cover of this manual. Connector damage resulting from improper use is not covered under warranty.

Equipment Available But Not Supplied

The following equipment is available from Hewlett-Packard for use with the Noise Sources:

~~11711A~~	~~Noise Source Adapter~~
5060-0343	3/4" Torque Wrench (APC-7)
5060-0344	9/16" Torque Wrench (APC-3.5)

~~The 11711A Adapter is used with the Hewlett-Packard Model 340B and 342A Noise Figure Meters to drive the 346A and 346B Noise Sources. The adapter does not provide enough current to drive the 346C Noise Source. Refer to the Operating and Service Manuals for the 340B, 342A, and 11711A for further information.~~

Options

The 346A and 346B Noise Sources are available with the following output connector options:

Option 001, Type-N (male)
Option 002, APC-7
Option 004, Type-N (female)

Since the APC-7 and Type-N connectors do not operate up to 26.5 GHz, no output connector options are available for the 346C.

Recommended Test Equipment

Table 4 is a list of equipment that can be used to perform an operational verification check.

INSTALLATION

Handling Precautions

CAUTION

Do not disassemble the Noise Source. The diode module is static sensitive and can be damaged or the calibration can be altered.

CAUTION

Do not drop the Noise Source. Dropping can damage unit or alter the calibration.

Table 4. Recommended Test Equipment For Operator's Checks

Check No.	Instrument	Critical Specification	Recommended Model
1	Power Meter and Power Sensor	Minimum Sensitivity 0.1 nW Frequency range: 10 MHz to 18 GHz	HP 436A with HP 8484A
	Power Supply	Voltage: 28.0 ±1.0V Current: 100 mA	HP 6218A
2	Noise Figure Meter	Voltage Output 28.0 ±1.0V Input Noise Figure: <7.4 FdB @ 100 MHz	HP 8970A

Proper connector care is essential. See OPERATOR'S MAINTENANCE in the OPERATION section of this manual for more information.

Initial Inspection

Inspect the shipping container for damage. Inspect the Noise Source for mechanical damage incurred in transit. If the shipping container or cushioning material is damaged, it should be kept until the contents of the shipment have been checked for completeness and the Noise Source has been mechanically and electrically checked. If the contents are incomplete, if there is mechanical damage or a defect, or if the Noise Source does not work electrically, notify the nearest Hewlett-Packard office. If the shipping container is damaged, or the cushioning material shows signs of unusual stress, notify the carrier as well as the Hewlett-Packard office. Keep the shipping materials for the carrier's inspection.

Original Packaging

Container and materials identical to those used in factory packaging are available through Hewlett-

Original Packaging (cont'd)

Packard offices. If the Noise Source is being returned to Hewlett-Packard for servicing, attach a tag indicating the name and address of the company, the technical contact person, phone number and extension, the model number, serial number, type of service being requested, and failure symptoms if applicable. For this purpose, blue service tags have been provided at the back of this manual. Mark the shipping container FRAGILE. In any correspondence, refer to the Noise Sources by model number and serial number.

Mating Connectors

The Noise Sources can be mated with other instrumentation having the connectors listed in Table 5.

Table 5. Connectors That Can Be Mated With the Noise Sources

Configuration	Mating Connector
Input: all units	BNC male*
Output: standard	APC-3.5 female SMA female
Opt. 001	Type-N female*
Opt. 002	APC-7
Opt. 004	Type-N male*

*Must comply with U.S. Military Standard MIL-C-39012.

Storage and Shipping Environment

The Noise Sources should be stored in a clean, dry environment. The following environmental limitations apply to both storage and shipment:
Temperature: –55°C to +75°C
Humidity: <95% relative
Altitude: <15 300 metres (50 000 feet)

OPERATION

This section refers to operation with noise figure meters. For more detailed operating instructions, refer to the operating manual for the noise figure meter used.

CAUTION

Use a dc blocking capacitor to protect the Noise Source from damage when connected to any system where a dc voltage is present on the output center conductor.

Noise figure measurements of devices (such as amplifiers, mixers, transistors, and receivers) can be made using the Noise Source with a noise figure meter. Figure 2 depicts a simple test setup for a noise figure measurement. Note that the noise figure meter must have a +28 ± 1V switched supply.

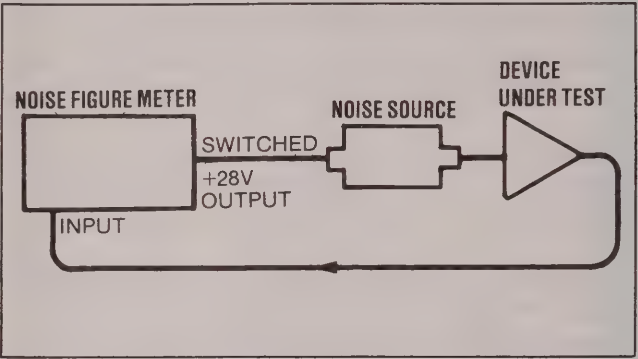

Figure 2. Typical Noise Figure Measurement Test Setup

Operating Environment

The operating environment of the Noise Sources should be within the following limitations:
Temperature: 0°C to +55°C
Humidity: <95% relative
Altitude: <4600 metres (15 000 feet)

Operator's Checks

The operator's checks in this section should be performed if failure of the Noise Source is suspected. The checks can be used only to verify that the Noise Sources are producing a broadband noise spectrum. They can not be used to check the units against specifications. Only one of the checks is necessary to verify operation. Table 4 shows the recommended test equipment used for each check.

Operator's Check with Power Meter (Check No. 1). Connect the equipment as shown in Figure 3 and follow this procedure:

1. Turn power supply off and zero set the power meter.

2. Turn power supply on (+28V) and measure the power output with the Noise Source on.

3. If the result of the measurement is within the following limits, the Noise Source is operating correctly:

   a. 346A Power output= –66 ± 4 dBm
   b. 346B Power output= –56 ± 4 dBm
   c. 346C Power output= –56 ± 4 dBm.

Operator's Checks (cont'd)

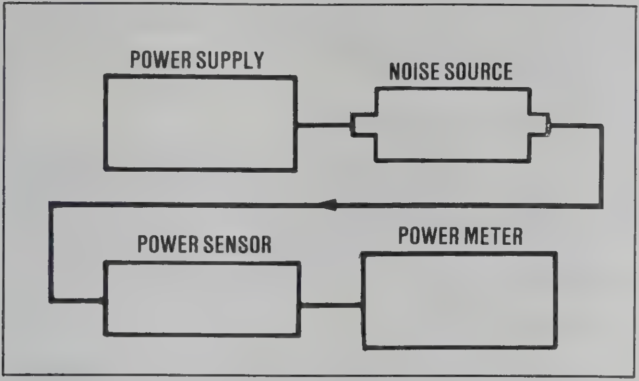

Figure 3. Operator's Check Test Setup 1

Operator's Check With HP Model 8970A Noise Figure Meter (Check No. 2)

1. Remove any cables from the noise figure meter input. Press PRESET. Verify Noise Figure display shows, "--FdB" and left display shows "30 MHz" after 5 seconds.

2. Connect the equipment as shown in Figure 4.

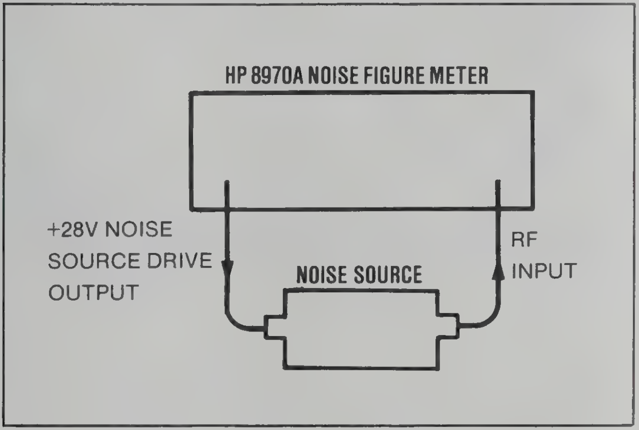

Figure 4. Operator's Check Test Setup 2

3. Enter a tuned frequency of 100 MHz. (See FIXED FREQUENCY TUNING in the 8970A Operating and Service Manual).

4. Enter special function 5.3 to enable the instrument for spot ENR entry. (See SPECIAL FUNCTIONS in the 8970A Operating and Service Manual).

5. Enter the ENR at 100 MHz from the Noise Source calibration label. (See SPOT ENR, T_{hot}, AND T_{cold} in the 8970A Operating and Service Manual).

6. The noise figure measurement of the noise figure meter will appear in the Noise Figure display. If the result of the measurement is less than 7.4 FdB, the Noise Source is operating.

7. Press PRESET to return the instrument to preset conditions.

Operator's Maintenance

Proper connector care is a vital part of the maintenance which should be performed by the user. By following the general connector care practices outlined below, the life of the connector can be greatly extended.

1. Connectors should be properly torqued as shown in Table 6.

Table 6. Connector Torque Specifications

Connector Type	Torque Specifications
N	10 in · lb (1.1 N · m)
APC-7	12 in · lb (1.3 N · m)
SMA to APC-3.5	8 in ·lb (0.9 N · m)
APC-3.5 to APC-3.5	8 in · lb (0.9 N · m)

2. Always tighten or loosen a connector by rotating only the nut. Never rotate the Noise Source body.

3. Use isopropyl or ethyl alcohol on a swab to clean connectors. Absorbent, lint-free paper wrapped around the end of tweezers is recommended. Carefully clean the conductive surfaces and dielectric. After cleaning, be sure connector is blown dry before re-assembly.

4. It is good practice to inspect a connector after cleaning. During the inspection, check for contaminants and worn plating. Also check for a misaligned center conductor or spread fingers on the APC-3.5 or Type-N connectors.

5. Support the cable or component attached to the connector.

6. When using APC-7 connectors, the nut of one connector should always be backed off completely and the nut on the mating connector should be tightened. Never set an APC-7 connector on its mating surface. Before storage, always screw the nut out to protect the surfaces.

Operator's Maintenance (cont'd)

7. Be sure connectors are axially aligned before the nut is tightened.

8. Use a connector gauge periodically to check the center pin depth. The shoulder of the center conductor must never extend beyond the plane of the outer conductor mating surface in an APC-3.5 connector.

For a more complete description of connector care, refer to application note 326-1 entitled "Connector Care and Maintenance". A copy of this note may be obtained through the nearest Hewlett-Packard office.

PERFORMANCE TESTS

Due to the complex test equipment involved, there are no recommended performance tests for the user to perform. Return the Noise Sources to Hewlett-Packard when tests are required to verify its performance and for periodic re-calibration. The suggested interval before initial re-calibration is one year.

ADJUSTMENTS

There are no adjustments that can be made on the Noise Sources by the user.

REPLACEABLE PARTS

If any parts need replacement, return the instrument to Hewlett-Packard.

SERVICE

Troubleshooting

Check the connectors. If there is no apparent damage to the connectors, perform one of the operator's checks described in the OPERATION section of this Manual. If the Noise Source's output does not fall within the stated range, or if the connectors are damaged, return the unit to Hewlett-Packard for repair.

Repair

Repair by the user is not recommended because of the complex equipment required for test and calibration.

APPENDIX
MANUAL CHANGES

INTRODUCTION

This section contains information for adapting this manual to Model 346B Noise Sources that have a serial number prefix which is 2330A and lower.

MANUAL CHANGES

To adapt this manual to your instrument, refer to Table 7 and make all of the manual changes listed opposite your instrument's serial number prefix. Perform these changes in the sequence listed.

If your instrument (all models) has a serial number prefix which is higher in value than those listed on the title page of this manual, it may be documented in a yellow MANUAL CHANGES supplement. For additional information, refer to INSTRUMENTS COVERED BY MANUAL in the GENERAL INFORMATION section of this manual.

Table 7. Manual Changes by Serial Number

Serial Number Prefix	Make Manual Changes
1935A, 2015A	C, B, A
2037A	C, B
2330A	C

CHANGE A

Table 2. Supplemental Characteristics:

Change Switching Speed for both repetitive operation and single shot operation to read: Turn off <140 μs.

CHANGE B

Table 1. Specifications:

Change "Worst Case Uncertainty" and "Root Sum of Squares Uncertainty" for cardinal frequencies from 10 MHz through 18 GHz to read as follows:

Frequency (MHz)	Worst Case Uncertainty (dB)	Root Sum of Squares Uncertainty (dB)
10	0.34	0.10
100	0.34	0.10
1000	0.34	0.10
2000	0.34	0.10
3000	0.34	0.10
4000	0.34	0.10
5000	0.35	0.10
6000	0.35	0.10
7000	0.37	0.10
8000	0.37	0.10
9000	0.38	0.13
10000	0.39	0.13
11000	0.39	0.14
12000	0.40	0.14
13000	0.50	0.18
14000	0.51	0.18
15000	0.52	0.18
16000	0.54	0.18
17000	0.55	0.18
18000	0.57	0.19

CHANGE C

Figure 1. Typical Calibration Label:

Replace Figure 1 with Figure A-1.

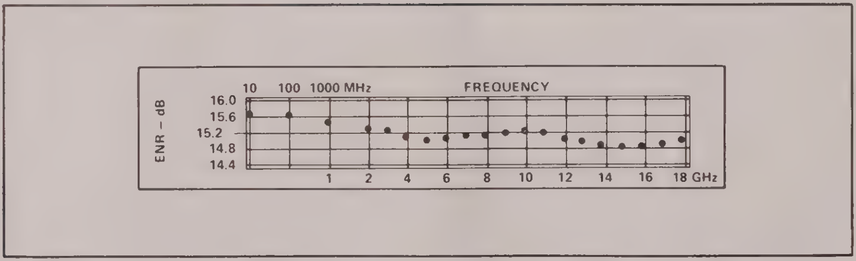

Figure A-1. Typical Calibration Label

Page 2, 2nd Paragraph under Description:

Change 1st sentence to read, "The Excess Noise Ratio (ENR) for each Noise Source has been measured at major frequencies and plotted on a label. . ."

Page 3, under Equipment Available But Not Supplied:
Delete, "5060-0344 . . . . . . 9/16" Torque Wrench (APC-3.5)".

NOTE

Model 346B Noise Sources manufactured before the printing of this manual have an APC-3.5 connector of a different configuration (see Figure A-2). The 9/16" torque wrench will not fit these older connectors.

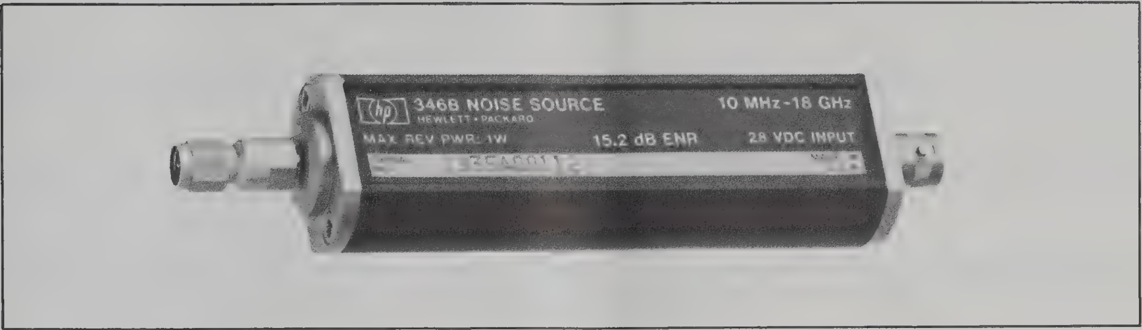

Figure A-2. HP Model 346B Noise Source with Older Configuration APC-3.5 Connector

CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and to the calibration facilities of other International Standards Organization members.

WARRANTY

This Hewlett-Packard instrument product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by HP. Buyer shall prepay shipping charges to HP and HP shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to HP from another country.

HP warrants that its software and firmware designated by HP for use with an instrument will execute its programming instructions when properly installed on that instrument. HP does not warrant that the operation of the instrument, or software, or firmware will be uninterrupted or error free.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. HP SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

EXCLUSIVE REMEDIES

THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. HP SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

ASSISTANCE

Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products.

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SO. CALIFORNIA (Los Angeles Area)
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Fullerton, CA 92631
GEORGIA
450 Interstate N. Parkway
Atlanta, GA 30348
ILLINOIS
5201 Tollview Dr.
Rolling Meadows, IL 60008
NEW JERSEY
W. 120 Century Rd.
Paramus, NJ 07652

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Canada L4V 1M8

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Hewlett-Packard France
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Boite Postale No. 6
F-91401 Orsay Cedex

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Hewlett-Packard GmbH
Vertriebszentrale Frankfurt
Bernerstrasse 117
Postfach 560 140
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NL-Amstelveen 1134

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GB-Winnersh, Wokingham
Berks, RG11 5AR

AFRICA, ASIA, CENTRAL AND SOUTH AMERICA

Hewlett-Packard Intercontinental
3200 Hillview Avenue
Palo Alto, CA 94304

HEWLETT
PACKARD

HP Part No. 00346-90010

Printed in U.S.A.

HEWLETT PACKARD

CALIBRATION REPORT

MODEL: 346A
DATE: OCTOBER 05 1989

SERIAL NO: 2614A01785
TECHNICIAN: 8631

FREQUENCY	ENR	REFL - ON		REFL - OFF		REFL
MHz	dB	MAG	ANG	MAG	ANG	CHANGE
10	5.43	.018	-170.5	.013	-168.3	.005
100	5.54	.018	173.8	.013	176.0	.005
1000	5.47	.013	110.1	.012	131.6	.005
2000	5.31	.014	-1.7	.016	13.4	.005
3000	5.16	.016	-71.5	.021	-72.6	.004
4000	5.19	.027	-123.7	.027	-132.1	.004
5000	5.30	.036	-174.8	.033	-173.9	.004
6000	5.36	.039	127.8	.039	133.1	.004
7000	5.49	.032	69.9	.035	70.4	.003
8000	5.68	.023	5.9	.024	-1.4	.003
9000	5.73	.022	-78.6	.020	-86.3	.003
10000	5.80	.034	-163.4	.030	-163.4	.003
11000	5.81	.050	132.4	.049	135.9	.003
12000	5.74	.062	77.2	.065	78.3	.003
13000	5.65	.066	24.1	.068	21.7	.003
14000	5.43	.061	-29.8	.058	-31.0	.003
15000	5.32	.043	-93.2	.042	-90.2	.003
16000	5.14	.027	177.6	.027	-177.8	.002
17000	5.05	.034	72.6	.036	74.9	.003
18000	4.82	.053	5.3	.055	3.8	.002

HEWLETT PACKARD

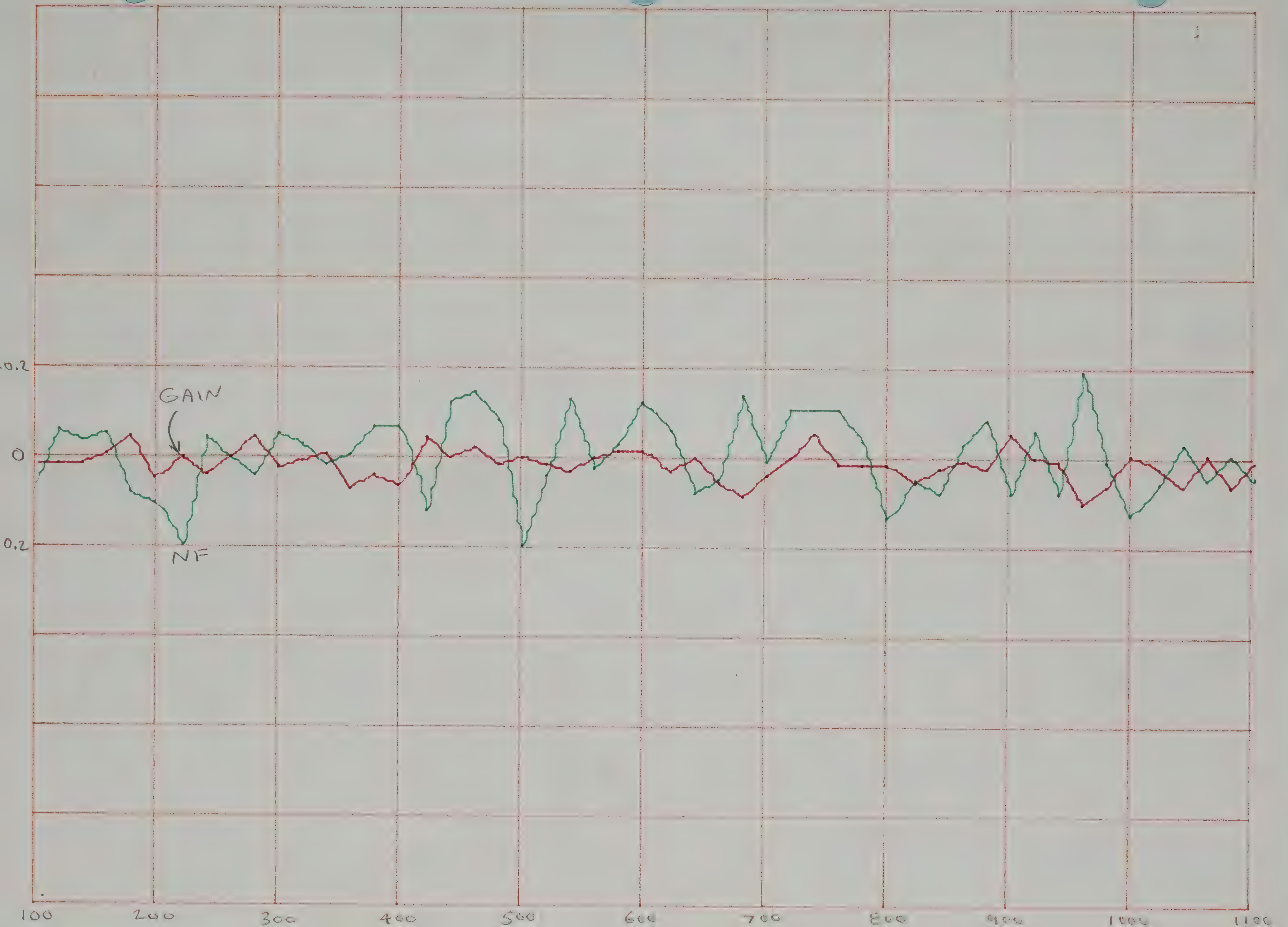
CALIBRATION REPORT

MODEL: 346A OPT 001
DATE: OCTOBER 09 1987

SERIAL NO: 2614A01073
TECHNICIAN: 222175

FREQUENCY	ENR	REFL - ON		REFL - OFF		REFL
MHz	dB	MAG	ANG	MAG	ANG	CHANGE
10	5.15	.007	-22.8	.012	-12.3	.005
100	5.31	.008	2.3	.012	-4.3	.005
1000	5.11	.012	-42.7	.011	-64.8	.005
2000	4.94	.016	-147.2	.012	-143.9	.004
3000	4.85	.014	113.0	.014	129.8	.004
4000	4.83	.008	41.0	.011	42.9	.004
5000	4.85	.009	14.9	.007	-7.3	.004
6000	4.91	.008	-31.6	.008	-8.1	.003
7000	4.94	.003	-83.7	.006	-80.6	.003
8000	5.04	.005	64.9	.008	85.4	.003
9000	5.27	.011	43.0	.012	28.6	.003
10000	5.30	.019	-14.4	.016	-12.8	.003
11000	5.32	.017	-88.6	.018	-78.8	.003
12000	5.34	.015	165.8	.018	169.6	.003
13000	5.27	.022	46.1	.024	44.3	.003
14000	5.20	.040	-32.9	.040	-36.7	.003
15000	5.20	.052	-110.8	.050	-110.5	.003
16000	5.16	.048	169.2	.048	172.2	.003
17000	5.19	.041	70.4	.044	71.7	.002
18000	5.16	.056	-36.3	.058	-37.4	.002

NOISE SOURCE SELF-MEASUREMENT



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Should one of your HP instruments need repair, the HP service organization is ready to serve you. However, you can help us serve you more effectively. When sending an instrument to HP for repair, please fill out this card and attach it to the product. Increased repair efficiency and reduced turn-around time should result.

COMPANY

ADDRESS

TECHNICAL CONTACT PERSON

PHONE NO. EXT.

MODEL NO. SERIAL NO.

MODEL NO. SERIAL NO.

P.O. NO. DATE

Accessories returned with unit

☐ NONE ☐ CABLE(S)

☐ POWER CABLE ☐ ADAPTER(S)

OTHER

over

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MODEL NO. SERIAL NO.

MODEL NO. SERIAL NO.

P.O. NO. DATE

Accessories returned with unit

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☐ POWER CABLE ☐ ADAPTER(S)

OTHER

over

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MODEL NO. SERIAL NO.

MODEL NO. SERIAL NO.

P.O. NO. DATE

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☐ POWER CABLE ☐ ADAPTER(S)

OTHER

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MODEL NO. SERIAL NO.

MODEL NO. SERIAL NO.

P.O. NO. DATE

Accessories returned with unit

☐ NONE ☐ CABLE(S)

☐ POWER CABLE ☐ ADAPTER(S)

OTHER

over

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COMPANY

ADDRESS

TECHNICAL CONTACT PERSON

PHONE NO. EXT.

MODEL NO. SERIAL NO.

MODEL NO. SERIAL NO.

P.O. NO. DATE

Accessories returned with unit

☐ NONE ☐ CABLE(S)

☐ POWER CABLE ☐ ADAPTER(S)

OTHER

over

5955-8108

Service needed

☐ CALIBRATION ONLY
☐ REPAIR ☐ REPAIR & CAL

OTHER

Observed symptoms/problems

FAILURE MODE IS:

☐ CONSTANT ☐ INTERMITTENT

SENSITIVE TO:

☐ COLD ☐ HEAT ☐ VIBRATION

FAILURE SYMPTOMS/SPECIAL CONTROL SETTINGS

If unit is part of system list model number(s) of other interconnected instruments.

9320-3896 Printed in U.S.A.

Service needed

☐ CALIBRATION ONLY
☐ REPAIR ☐ REPAIR & CAL

OTHER

Observed symptoms/problems

FAILURE MODE IS:

☐ CONSTANT ☐ INTERMITTENT

SENSITIVE TO:

☐ COLD ☐ HEAT ☐ VIBRATION

FAILURE SYMPTOMS/SPECIAL CONTROL SETTINGS

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9320-3896 Printed in U.S.A.

Service needed

☐ CALIBRATION ONLY
☐ REPAIR ☐ REPAIR & CAL

OTHER

Observed symptoms/problems

FAILURE MODE IS:

☐ CONSTANT ☐ INTERMITTENT

SENSITIVE TO:

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9320-3896 Printed in U.S.A.

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OTHER

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FAILURE MODE IS:

☐ CONSTANT ☐ INTERMITTENT

SENSITIVE TO:

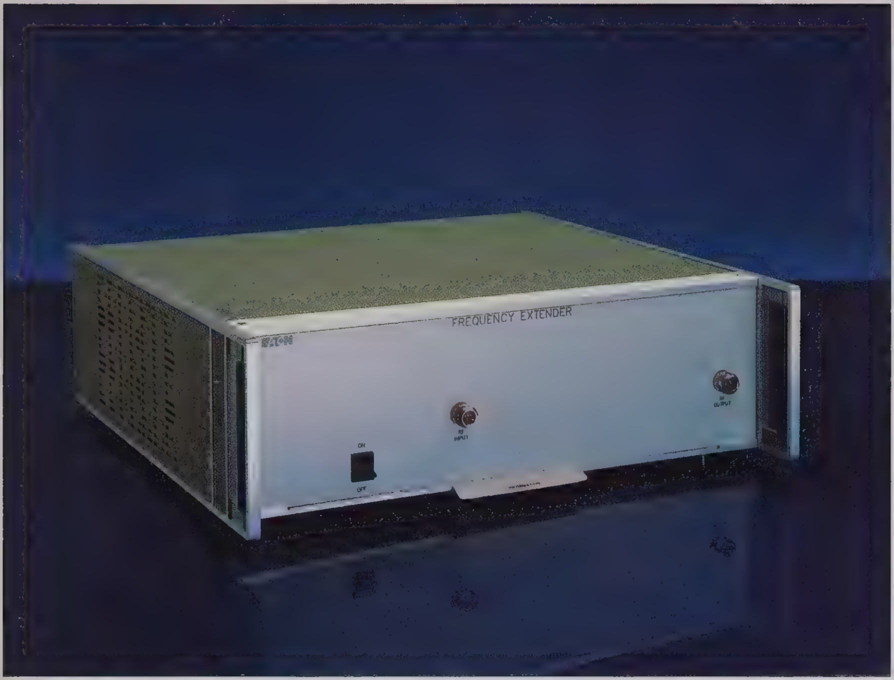
☐ COLD ☐ HEAT ☐ VIBRATION

FAILURE SYMPTOMS/SPECIAL CONTROL SETTINGS

If unit is part of system list model number(s) of other interconnected instruments.

9320-3896 Printed in U.S.A.

Eaton
Frequency Extenders



Eaton Frequency Extenders offer high precision microwave noise figure measurement capability in one complete systems approach.

Eaton Frequency Extenders provide downconversion for microwave noise measurement over the frequency range from 10 MHz to 26.5 GHz. A number of Frequency Extender products are available to give you maximum flexibility. In one box the Eaton 2160 and 2161 Frequency Extenders contain all the necessary hardware for precision microwave noise downconversion, including the appropriate Local Oscillator, and all the necessary Low Noise Amplifiers and Isolators. Or choose the Eaton 2150 or 2151 Frequency Exenders which provide basic downconversion capability while letting you decide to add the Local Oscillator, Low Noise Amplifiers and Isolators your application calls for. No matter which Eaton Frequency Extender you choose, you will be getting high precision microwave noise figure measurement capability in one complete systems approach.

Features

- **Low Noise -** For more accurate noise figure measurements.
- **Low VSWR -** Lower mismatch means less uncertainty in the actual noise figure measurements.
- **Convenience -** Everything you need for microwave noise figure measurement.
- **Cost-Effective -** No external equipment is required, and there is no need to design, assemble, or debug the measurement system.
- **Variety of Downconverter Options -** Many options to accommodate a variety of requirements.
- **True Single Sideband Measurement -** For less uncertainty in noise figure measurements.

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Technical Specifications
Eaton Frequency Extenders

Specifications	**2150**	**2151**	**2160**	**2161**
Frequency Range	10 MHz to 18 GHz	10 MHz to 26.5 GHz	10 MHz to 18 GHz	10 MHz to 26.5 GHz
Input VSWR	<2	<2	<1.7 typical	<1.7 typical
Noise Figure (typical)	<19 dB	<20 dB	<13 dB	<15 dB, 10 MHz to 18 GHz <17 dB, 18 GHz to 26.5 GHz
Repeatability	0.2 dB	0.2 dB	0.2 dB	0.2 dB
Image Rejection	>40 dB	>40 dB	>40 dB	>40 dB
Measurement Mode	Single Sideband	Single Sideband	Single Sideband	Single Sideband
Power Requirements	200 VA max	230 VA	225 VA max	300 VA max
Size	5¾″ x 16⅞″ x 14″ (14.6 x 42.86 x 35.56 cm)	5¾″ x 16⅞″ x 14″ (14.6 x 42.86 x 35.56 cm)	5¾″ x 16⅞″ x 14″ (14.6 x 42.86 x 35.56 cm)	5¾″ x 16⅞″ x 14″ (14.6 x 42.86 x 35.56 cm)
Weight	15 lbs	15 lbs	25 lbs	25 lbs

Options

Opt. 201	Add Local Oscillator to Model 2150
Opt. 202	Add Low Noise Amplifiers and Isolators to Model 2150
Opt. 203	Add Local Oscillator to Model 2151
Opt. 204	Add Low Noise Amplifiers and Isolators to Model 2151

EATON

Eaton Corporation
Electronic Instrumentation Division
5340 Alla Road
Los Angeles, California 90066
213/822-3061

In the interest of product improvement, all specifications, are subject to change without notice.

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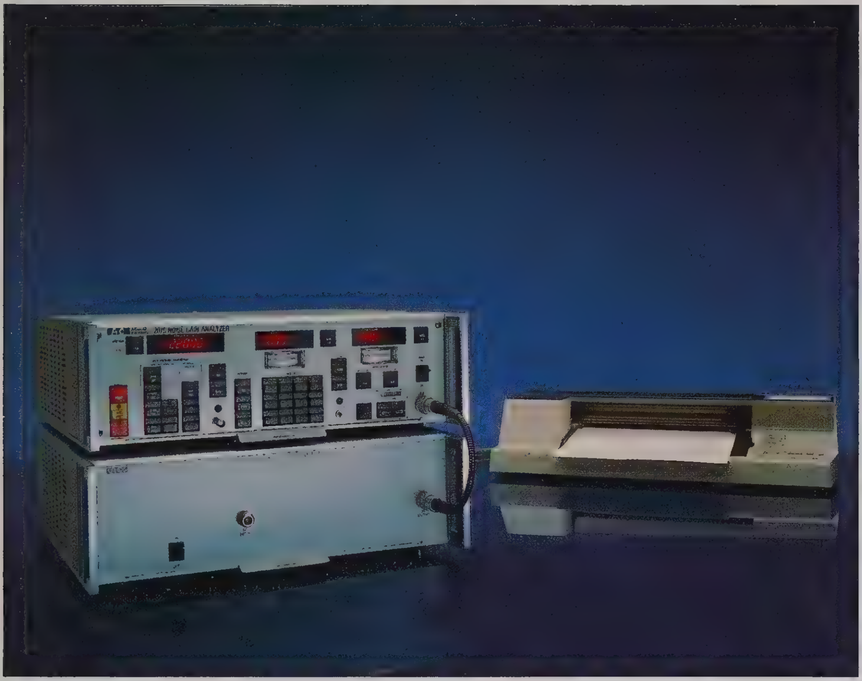
Eaton 2275S/2276S
Noise Figure Test Systems



The Eaton Noise Figure Test Systems offer a complete systems approach with digital plotter capability.

Features

- Low Noise Figure
- Low VSWR
- Complete System Approach
- Convenience
- Cost Effective
- Direct Digital Plotter Output
- True Single Sideband Measurement
- Variety of Downconversion Options

For companies requiring high precision microwave noise measurement, Eaton introduces its 2275S and 2276S Noise Figure Test Systems. The 2275S and 2276S offer precise microwave noise measurements from one self contained, pre-specified and cost effective system. All the necessary low noise amplifiers, noise generators, cable and accessories are integrated directly into the systems.

The Eaton 2275S and 2276S Noise Figure Test Systems put an end to complex and expensive measurement of noise figure at microwave frequencies.

The primary factors affecting accuracy in noise figure measurement are VSWR and the noise figure of the measurement system. The Eaton 2275S and 2276S systems achieve higher accuracy than laboratory assembled systems because they include the low noise amplifiers and isolators — giving them a low noise figure and good VSWR.

Another important factor in noise figure measurement is repeatability. The Eaton 2275S and 2276S systems have built-in local oscillators with precision tracking of the pre-selector to insure high repeatability in noise figure measurement.

Eaton's unmatched experience, stemming from its long head start and leadership in noise technology, have made the 2275S and 2276S the Noise Figure Test Systems today's market needs.

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Technical Specifications
Eaton 2275S and 2276S Noise Figure Test Systems

Specifications	Eaton 2275S	Eaton 2276S
Input Specifications		
Frequency Range	10 MHz to 18 GHz	10 MHz to 26.5 GHz
Input VSWR	<1.7 typical	<1.7 typical
Noise Figure	< 13 dB	<15 dB, 10 MHz to 18 GHz <17 dB 18 GHz to 26.5 GHz
Repeatability	0.2 dB	0.2 dB
Net External Gain, max	40 dB	40 dB
Maximum Input Power	+20 dBm	+20 dBm
Noise Measurement		
Range	0 to 30 dB	0 to 30 dB
Instrumentation Uncertainty	<±0.25 dB	<±0.25 dB
Gain Measurement		
Range	−20 to +55 dB	−20 to +55dB
Instrumentation Uncertainty	< ±0.25 dB	< ±0.25 dB
System Components	Eaton 2075B Noise Gain Analyzer Eaton 2160 Frequency Extender (complete with the necessary local Oscillator, Low-Noise Noise Amplifiers and isolators) Eaton 2618E Noise Generator Eaton 2955 Cable and Adapter Kit	Eaton 2075B Noise Gain Analyzer Eaton 2161 Frequency Extender (complete with the necessary local Oscillator, Low-Noise Noise Amplifiers and isolators) Eaton 2626 Noise Generator Eaton 2956 Cable and Adapter Kit
General		
Power Requirements	375 VA max	450 VA max
Size	12″ x 16⅞″ x 14″ (29.2 x 42.86 x 35.56 cm)	12″ x 16⅞″ x 14″ (29.2 x 42.86 x 35.56 cm)
Weight	50.5 lbs	50.5 lbs

Eaton 2275S/2276S Supplemental Characteristics

Measurement Speed	6 to 10 measurements/second
ENR Storage Capacity	4 stored ENR tables total; 3 sets at 35 frequencies plus 1 ROM input
Image Rejection	> 40 dB
Measurement Mode	Single sideband
Plotter Capability	Digital plotter read-out capability for noise figure and gain versus frequency plot with grid, title and noise figure, gain, and frequence axis annotation
Compatible Digital Plotters	HP 7470A, 7475A, 7550A, 7440A, 9872B

The Eaton 2075B Noise-Gain Analyzer controls the Eaton Frequency Extenders via the System Interface Bus.

EATON

Eaton Corporation
Electronic Instrumentation Division
5340 Alla Road
Los Angeles, California 90066
213/822-3061

In the interest of product improvement, all specifications are subject to change without notice.

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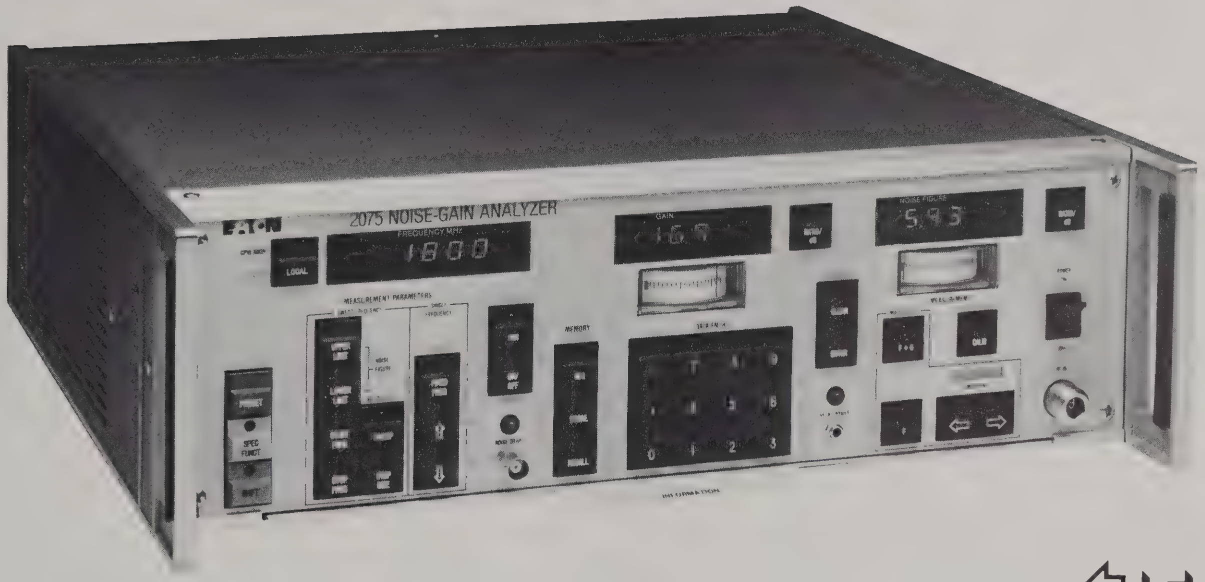
Eaton 2075
Noise-Gain Analyzer

NEW **2075B Noise Gain Analyzer**
With added features for enhanced performance

Frequency Range . . . . 10 MHz to 1.8 GHz
(2 GHz with Option 205)
Noise Figure . . . . . . ‹8.5 dB, 10-30 MHz
‹6 dB, 30-2000 MHz
VSWR . . . . ‹1.7
Gain Range Measurement -20 to + 55 dB
Plotter Capacity: Digital Plotter read-out capability
System Interface Bus capable of controlling a Frequency Extender

A Microprocessor Based, Computer Compatible Instrument



IEEE 488 GPIB

Noise Figure and Gain Measurements made:
- Simple
- Convenient
- Over Wide Frequency Ranges

…with Outstanding Accuracy, Resolution and Precisio

EATON

FOR COMPLETE APPLICATION & SALES INFORMATION CALL

Bruce Bishop

EATON

Electronic Instrumentation Division
5340 Alla Road
Los Angeles, CA 90066
(213) 827-1270
(213) 822-3061

Form P407-5 (4/84)

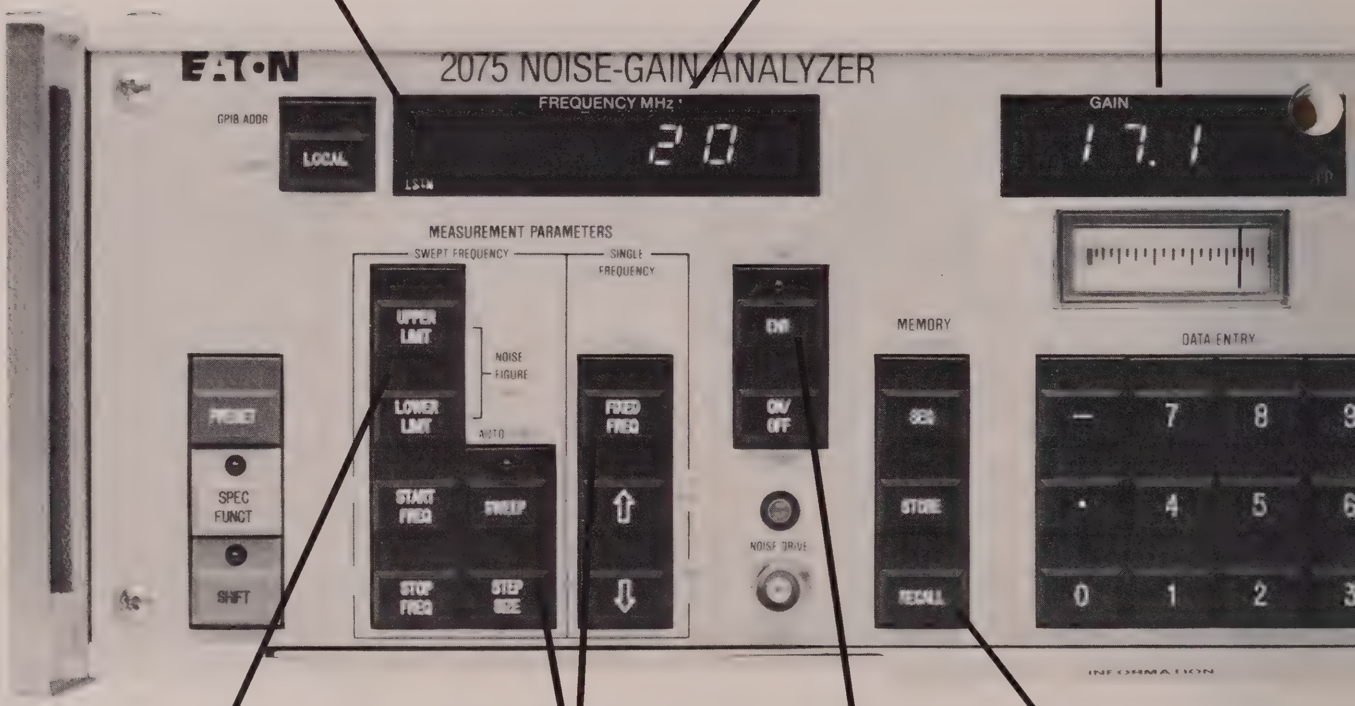
2075-2A 10 to 1850 MHz (Tunable) Noise-Gain Analyzer

GPIB (Standard)
Front Panel Status
Indicators

Large Easy-to-Read Displays for:

- Frequency
- Min/Max Limits for Swept Analog Displays

- Gain
- ENR



Front Panel HI/LO
Limit Set for Both
Noise Figure and Gain
for Analog Swept
Displays

Fixed Frequency or Automatic Swept Frequency Measurements in 100 kHz Steps for the Entire 10-1850 MHz Band

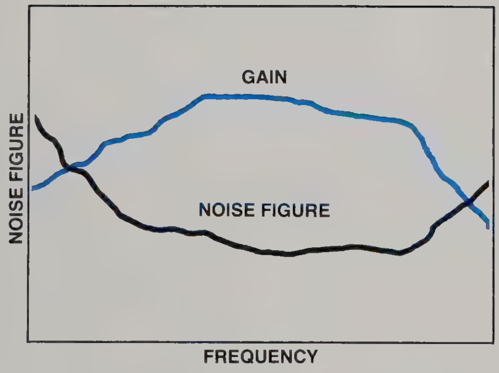
Simple, Easy to Use ENR Data Entry for up to 3 Noise Sources

Storage/Recall of up to 9 Different Front Panel Control Configurations

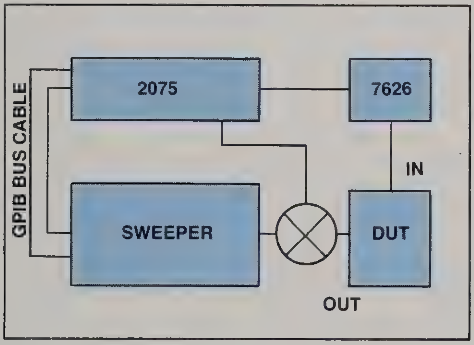
- Noise
- Effecti
  Noise
- Noise
- Y-fact
- Opera

Front Pa
of Displa
Over-ride
Function

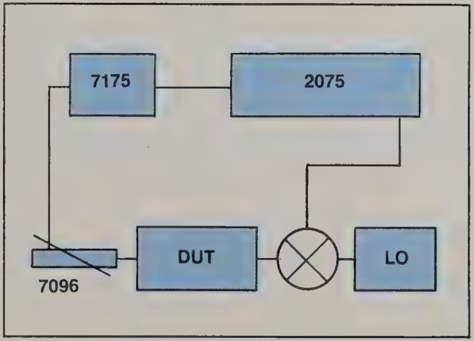
Measure • Noise Figure • Effective Input Noise Temperature • Gain • Noise Measure from 10 MHz to 40 GHz



10 MHz to 1850 MHz requires no additional preamplifiers, mixers, or accessories. A typical scope display is illustrated showing simultaneous readout of noise figure and gain vs. frequency. When using an Eaton 2075 Noise-Gain Analyzer for measurements in the 10 to 1850 MHz range, other than a noise generator, no external equipment is required. The rear panel makes available analog X-Y outputs that are compatible with most standard laboratory oscilloscopes and recorders. In addition there is a Z axis output, which can be used for blanking the oscilloscope or as a pen lift on a recorder.



Swept Microwave Measurements with an external local oscillator. The block diagram shows the set-up that can be used to make measurements anywhere from 1850 MHz to 26 GHz with an appropriate bus programmable local oscillator. The Eaton 2075 Noise-Gain Analyzer sends frequency commands over the interface bus to tune the local oscillator across the band of interest. This eliminates the need for a desk top computer or external controller for error corrected swept microwave measurements. All of the correct addressing and date formatting is provided by the Eaton 2075. The basic instrument will include the ability to control three specific industry-standard local oscillators. This feature is extremely valuable in testing broadband microwave amplifiers, mixers, and devices since, in addition to saving the cost of utilization of the computer, it eliminates a great deal of the programming or software effort that the computer will generally require.



Measurement Capability up to 40 GHz, Exclusive with Eaton Instrumentation! If your tests require measurements from 100 MHz to 26 GHz, the Eaton 7626 Solid State Noise Generator is the solution.

From 26 GHz to 40 GHz, where you must use a waveguide gas discharge noise generator, the Eaton instrumentation team of a remotely triggerable 7175 gas discharge noise generator power supply, a 2075 Noise-Gain Analyzer and a 7096 gas discharge noise generator provide the measurement capability with a compatible noise figure measurements system.

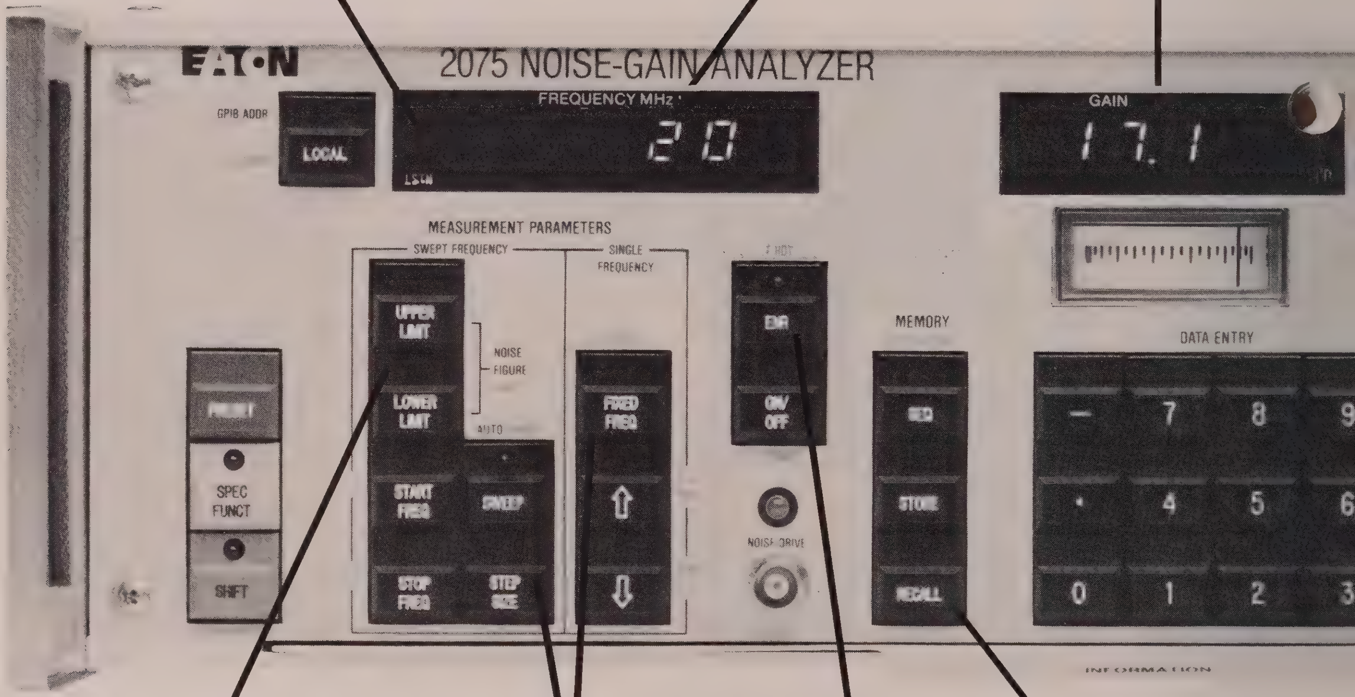
2075-2A 10 to 1850 MHz (Tunable) Noise-Gain Analyzer

GPIB (Standard)
Front Panel Status
Indicators

- Frequency
- Min/Max Limits
  for Swept
  Analog Displays

Large Easy-to-Read Displays for:

- Gain
- ENR



Front Panel HI/LO
Limit Set for Both
Noise Figure and Gain
for Analog Swept
Displays

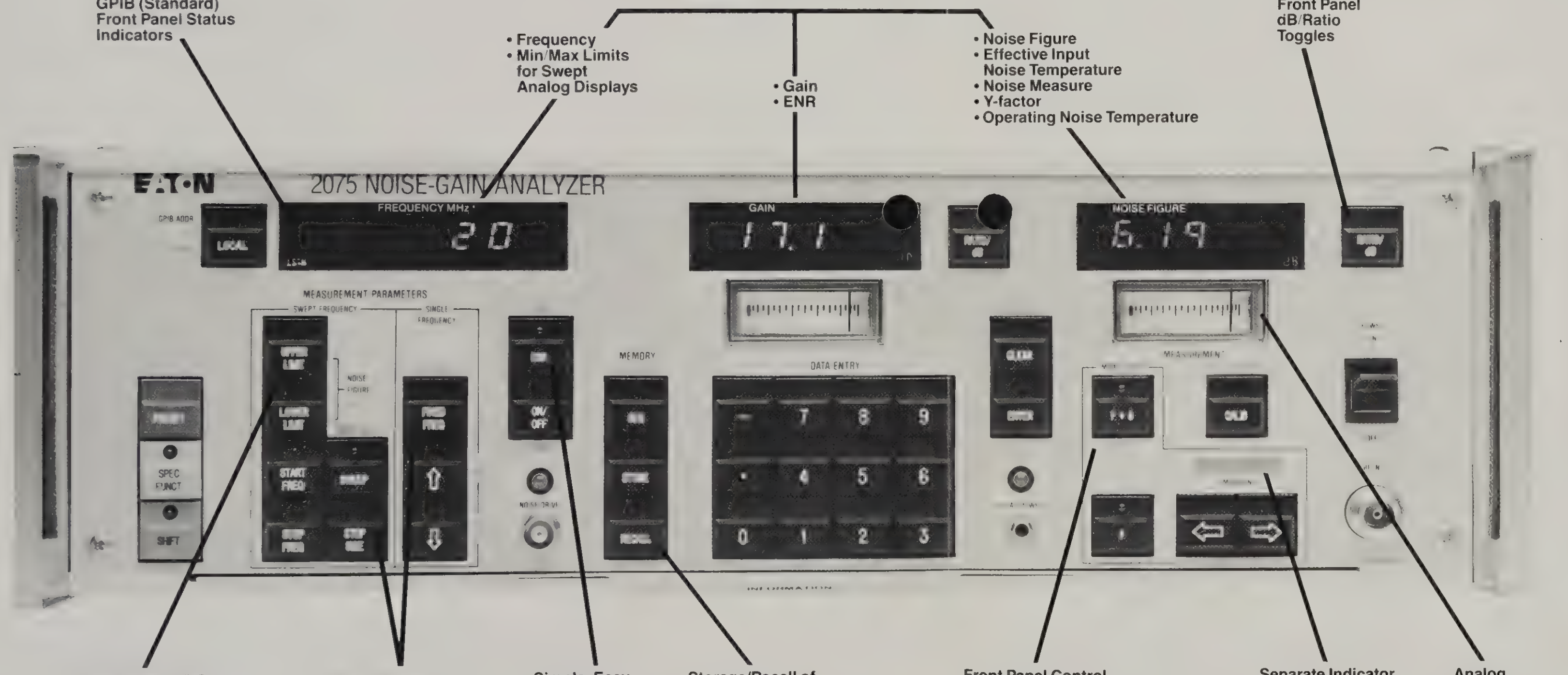
Fixed Frequency
or Automatic
Swept Frequency
Measurements in
100 kHz Steps for
the Entire 10-1850 MHz
Band

Simple, Easy
to Use ENR
Data Entry
for up to
3 Noise Sources

Storage/Recall of
up to 9 Different
Front Panel Control
Configurations

2075-2A 10 to 1850 MHz (Tunable) Noise-Gain Analyzer

IEEE 488 Bus Compatible



GPIB (Standard)
Front Panel Status
Indicators

Large Easy-to-Read Displays for:

- Frequency
- Min/Max Limits for Swept Analog Displays

- Gain
- ENR

- Noise Figure
- Effective Input Noise Temperature
- Noise Measure
- Y-factor
- Operating Noise Temperature

Front Panel
dB/Ratio
Toggles

Front Panel HI/LO
Limit Set for Both
Noise Figure and Gain
for Analog Swept
Displays

Fixed Frequency
or Automatic
Swept Frequency
Measurements in
100 kHz Steps for
the Entire 10-1850 MHz
Band

Simple, Easy
to Use ENR
Data Entry
for up to
3 Noise Sources

Storage/Recall of
up to 9 Different
Front Panel Control
Configurations

Front Panel Control
of Displayed Parameter,
Over-rides Special
Functions

Separate Indicator
for Smoothing
Factor

Analog
Indicators
for Both
Noise Figure
and Gain

ACCURACY

Many hours and dollars are often wasted tracking down the source of noise figure measurement inconsistencies among various set-ups (engineering, test, QA, vendor, incoming inspection, etc.). The Eaton 2075 Noise-Gain Analyzer can help save much of this effort because it features ±0.05 dB tracking accuracy at noise figures below 12dB (about ±1.2% for an effective input noise temperature of 4,300 kelvins). The accuracy specification is not restricted to a single environmental temperature (e.g.: 290k), but is fully valid over the range from +10 to +40°C.

CONVENIENCE

In the past, you have probably expended considerable effort assembling external mixers, local oscillators, preamplifiers, and other equipment, simply because the output frequency of your device under test did not match the tuned input frequency of the noise measuring instrument and/or the gain was too low for a valid measurement.

Over the range from 10 to 1850 MHz the Eaton 2075-2A Noise Gain Analyzer solves this problem for you. With simple keystroke entry, this instrument can be set to any frequency in this range or can be made to sweep over all or any part of the range in any increment down to 0.1 MHz.

X-Y outputs at the rear of the instrument permit simultaneous viewing of both noise figure and gain versus frequency regardless of the resolution selected.

The high sensitivity of the Eaton 2075 also makes external preamplifiers unnecessary. The Noise-Gain Analyzer is sensitive enough to measure its own noise figure, and can actually measure noise and gain characteristics of devices with up to 20 dB of loss.

An important characteristic of the double-conversion scheme used in the front-end of the Eaton 2075-2A Noise-Gain Analyzer is that it is virtually imageless; thus, you no longer need worry about the accuracy of image corrections (is it 3dB ? 2.7 ?, etc.) This is of particular importance in the HF, VHF and UHF ranges where amplifier gains may vary rapidly, and when measurements are being made near the band edge of a device.

AUTOMATIC ON-LINE SECOND-STAGE NOISE CORRECTIONS

In a noise figure measurement, the measured value is the over-all noise figure of the set-up including the measuring instrument. In the past, particularly if you were working with low-gain or lossy devices, you would have to correct all your measurement results for the noise contributions of the set-up subsequent to the output of the device-under-test. A cumbersome, time-consuming task.

Because of its high sensitivity and ability to measure its own noise figure, the Eaton 2075 Noise-Gain Analyzer relieves you of this burden. A simple calibration routine, resident within the instrument with no external controllers, stores 2nd stage noise figure of each frequency. From that point on, each measurement result is corrected and displayed in accordance with the standard, cascade noise figure relation. Due to the high speed of the internal microprocessor and A/D converter, these corrected measurements can be made at rates up to 5 per second further enhancing measurement efficiency and cost savings.

In computer-controlled applications, this feature can be called up via the GPIB; thus, you can also save the time normally required to write the necessary program module to correct the measured result.

SIMULTANEOUS GAIN MEASUREMENTS

Two major interactive characteristics of amplifiers, mixers, etc., are noise performance and gain. An adjustment or circuit change affecting one, will usually cause a shift in the other.

The Eaton 2075 Noise-Gain Analyzer provides you with the capability of observing both these performance criteria, either at a single frequency or swept over a band of frequencies. For relatively narrow band swept measurements, the 0.1 MHz resolution provides a detailed examination of the device passband and lessens the possibility of missing narrow discontinuities in either gain or noise performance.

To further aid you in adjusting or monitoring these key parameters simultaneously, *TWO* analog meters are provided on the front panel to simplify identification of minima or maxima in both noise and gain.

COLD REFERENCE TEMPERATURE CORRECTIONS

In general, noise figure measurements require the successive application of two known noise temperatures at the input of the device under test. Most laboratory noise figure instruments assume that the cold temperature is equal to the standard reference temperature of 290 kelvins (approximately 62°F). Since the typical laboratory noise generator, e.g. Eaton 76 Solid State Noise Generator, uses room temperature for cold temperature, an error can be introduced into the measurement. It is then necessary for the operator to make a manual correction on the basis of known formulas or program a computer to do the calculation for him. By simply entering the ambient room temperature into the Eaton 2075 Noise-Gain Analyzer prior to making the measurement, the instrument will automatically correct the displayed result for this effect, thus removing this time wasting calculation.

FRONT PANEL DISPLAY PARAMETER CONTROL

Quite often in microprocessor based instruments, such as the Eaton 2075 Noise-Gain Analyzer, you will find a number of extremely useful and highly utilized functions buried in a special functions table. The Eaton 2075 eliminates a good many of these special functions by providing a shift key, effectively doubling the number of useful front panel controls. For example: if your application requires a readout of effective input noise temperature, rather than noise figure, it can be done very simply from the front panel without the need for going to the special functions table. Equally important, the front panel display parameter controls over-ride the special functions. Therefore, if you are in a special function mode and you wish to return to the noise figure measurement mode, you need only depress the noise figure button on the front panel, without having to go back into another special function to exit.

AND IT'S A CONTROLLER, TOO!

The 2075-2A is specified up to 1850 MHz but is usable up to 1900 MHz. Measurements at higher frequencies require an external mixer and local oscillator to down convert the measurement frequencies into the range of the 2075-2A. If you want to achieve the cost and time savings available through automation, this local oscillator must be bus programmable, which generally requires the use of an external computer. With the Eaton 2075 Noise Gain Analyzer this is not necessary. The instrument has the capability of programming and controlling applicable industry standard, programmable local oscillators. In addition, when not controlling an external local oscillator or not under control of an external computer, the 2075 can be put in the TALK only mode and transmit the measurement data to a digital printer in the LISTEN only mode, thus providing a hardcopy readout.

2075 Noise-Gain Analyzer Specifications

NOISE MEASUREMENT

Noise Figure Range	0 to 30 dB
Measurement Accuracy	±.05 dB A) 0 to 12 dB Noise Figure B) +10 to +40°C C) ENR 5 to 18 dB ±0.1 dB A) 12 to 30 dB Noise Figure B) T <10°C, >40°C
Resolution	.01 dB

Measurement accuracy specifications are valid for uncorrected noise figure over the full gain measurement range of the instrument.

GAIN MEASUREMENT

Gain Range	−20 to >50 dB
Measurement Accuracy	±0.2 dB
Resolution	.01 dB
INPUT	
Frequency Range	10 to 1850 MHz, tunable to 1900 MHz
Tuning Accuracy	±(0.5 MHz + 0.005F), ±3 MHz Max
Frequency Resolution	0.1 MHz
Noise Figure	<7 dB + 0.002 dB/MHz A) Input Level < −40 dBm
Input VSWR	<1.5
Maximum Input Power	+20 dBm
Maximum Net External Gain	>75 dB

EMC–ELECTROMAGNETIC CAPABILITY

EMI	MIL-STD-461 CE03,RE02 CISPR Pub 11 (1975) VDE
EMS	MIL-STD-461 CS01, CS02, CS06, RS03, (1 V/M)

GENERAL

Noise Source Drive (ON)	+28 ±.05 V, up to 100 ma Available
(OFF)	<1 V
Operating Temperature	0 to 55°C
Storage Temperature	–55 to 75°C
Power	100, 120, 220 or 240 V (±10%) 48-66 Hz; 150 VA Max.
Weight	25.5 lbs., (11.5 kg)
Dimensions	5¾″ x 16⅞″ x 14″, (14.6 x 42.86 x 35.56 CM) (5¼″, 13.33 cm rack panel space)

FUNCTIONS & FEATURES

Noise Figure Display	F dB, F Y dB*, Y* Te(K)*, Top(K)* M*, dB PWR* Default display is FdB.

*require SP function. All others are front panel control. Return from, SP function is front panel control. dB/Ratio selection for F or Y is a front panel toggle.

Controller Functions	Wiltron 6600 HP 8672 A HP 8350 A General Format Digital Printer (Listen Only) 2075 (Talk Only)
ENR Storage Capacity	3 sets @ 31 frequencies 1 ROM input (4 total)
Analog Display Set-up	F & G min-max, front panel
External Relay Drive	5, 15 or 30 V, Operator selected by internal jumper
Programmability	IEEE-std.-488-1978

SUPPLEMENTAL CHARACTERISTICS

Bandwidth	5 MHz (nominal)
Measurement Speed	6 to 10 meas/sec
Maximum Safe Input Level	±20 Vdc; +20 dBm RF

ACCESSORIES

7615 10 MHz to 1500 MHz solid state Noise Generator

7616 1 GHz to 12.4 GHz solid state Noise Generator

7617 12.4 to 18 GHz solid state Noise Generator

7618 1 GHz to 18 GHz solid state Noise Generator

7618E 10 MHz to 18 GHz solid state Noise Generator

7626 10 MHz to 26.5 GHz solid state Noise Generator

7175 gas discharge noise generator Power Supply

70 series 8.2 to 40 GHz waveguide gas-discharge Noise Generators

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In the interest of product improvement specifications are subject to change without notice.

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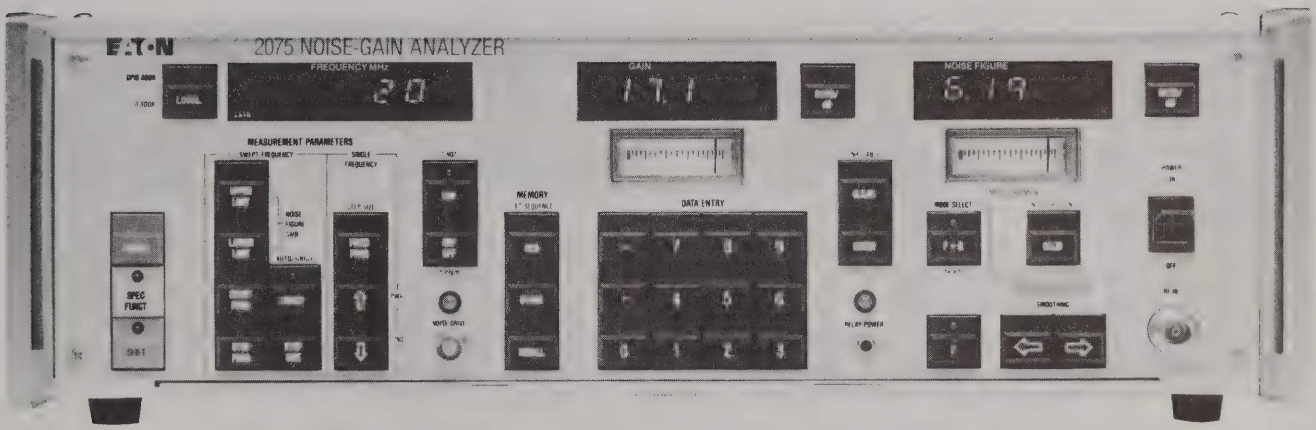
OPERATION MANUAL

Manual No. 1-500783-385

EATON 2075
NOISE-GAIN ANALYZER



REVISED DECEMBER 1985

Eaton Corporation
Electronic Instrumentation Division
Los Angeles, California 90066

WARRANTY

Eaton Corporation, Electronic Instrumentation Division, (SELLER) warrants each new instrument to be free from defects in material and workmanship, effective after delivery to the original purchaser as follows:

Electrical and Electronic Measuring Instruments ...... 1 Year

Repair or replacement (at our option) without charge (F.O.B. factory) will be effected when our examination satisfactorily indicates that defects are due to workmanship or materials. Electron tubes, semiconductors, batteries, fuses, lamps, thermoelements, and Ratio Tran potentiometers are excluded from warranty coverage. Warranty returns must first be authorized by the factory.

If the instrument or any portion thereof, has been abused, misused, damaged by accident or negligence, or if any serial number or seal has been removed or altered, the warranty is void.

This warranty is in lieu of all other warranties, express or implied INCLUDING THE IMPLIED WARRANTY OF MERCHANTABILITY, or fitness for a particular purpose. In no event shall the SELLER be liable for INCIDENTAL OR CONSEQUENTIAL damages. The SELLER neither assumes, nor authorizes any person to assume for it, any other liability in connection with sales of instruments manufactured by SELLER.

With respect to repairs, the foregoing warranty shall apply for a period of ninety days to the repaired portion.

REPAIR AND MAINTENANCE

Instruments should be returned only on prior authorization from the Representative or the factory. You will be advised of detailed shipping instructions at that time. Return the instrument to the factory prepaid. Validity of warranty will be determined by the factory.

Chargeable repairs: If requested, an estimate of charges will be made prior to repairs. Please provide us with the following information in order to expedite the processing of your instrument:

1. Model or Type
2. Serial Number
3. Description of trouble (1)
4. Approximate date instrument was placed in operation.
5. Approximate number of hours in use.
6. Maintenance action previously requested or performed
7. Other comments.

(1) Include data on symptoms, measurements taken, suspected location of trouble, maintenance action taken and any other relevant data

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SECTION I

GENERAL INFORMATION

1-1. SCOPE AND ORGANIZATION OF THE MANUAL

This manual contains information and procedures required to install and operate the Eaton 2075-2A Noise-Gain Analyzer. The manual is divided into five sections as follows:

Section 1: General Description

Section 2: Unpacking and Installation

Section 3: Operation In Local Mode

Section 4: GPIB Operation

Section 5: Performance Verification Procedures

NOTE

Eaton 2075 is the generic model designation for the Noise-Gain Analyzer. It was first released as the Eaton 2075-2; the most recent version is the Eaton 2075-2A. Both versions are identical in form, fit and function except that in the Eaton 2075-2A the basic input frequency range has been extended. The Eaton 2075-2 has an input frequency range of 10 MHz to 1800 MHz. The basic input frequency range of the Eaton 2075-2A is 10 MHz to 1850 MHz, per its specifications. However the unit is tunable to, and can actually be operated at, up to 1900 MHz. The actual model number is located on the identification label on the rear panel. The instrument is hereinafter referred to as the Eaton 2075.

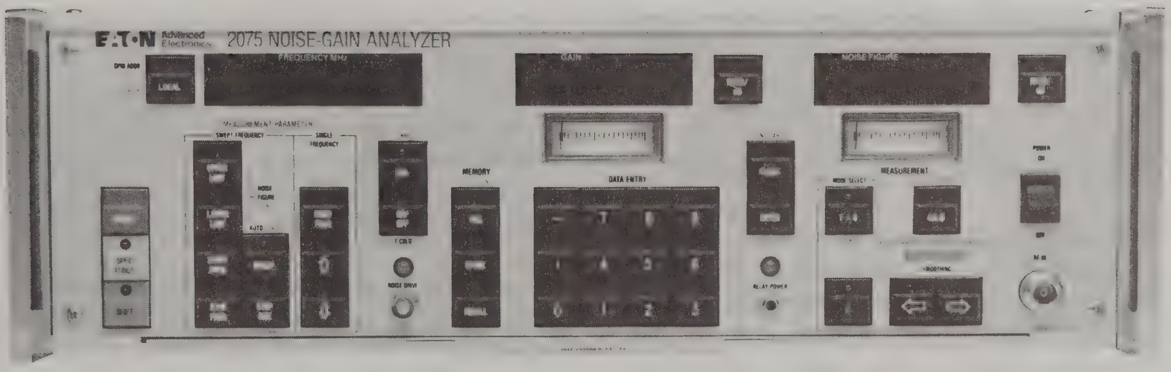


Figure 1-1. EATON 2075 NOISE-GAIN ANALYZER

This manual has been organized to allow the new user of the Eaton 2075 to quickly and easily begin test operations. Read Section 1 to obtain a familiarity with the test instrument. Follow the procedures of Section 2 for installation.

The Eaton 2075 can be used in any of 6 test configurations, depending on the desired test application. Section 3 is organized to quickly bring the user to the correct test configuration and its procedure. Figure 3-1 and Table 3-1 may be studied to obtain a familiarity with the controls and indicators. Paragraph 3-10 and Table 3-4 guide the user in selecting the correct test configuration. Paragraphs 3-11 through 3-18 are the procedures to be used with each configuration. Each procedure includes the keystroke sequences necessary for each step. The remaining pages of Section 3 cover, in greater detail, specific subjects relevant to operation of the 2075.

Section 4 covers operation when the 2075 is controlled by an external computer via a General Purpose Interface Bus.

Section 5 includes information and procedures used to verify that the 2075 is performing correctly.

1-2. INTRODUCTION

This section of the manual contains a general description of the Eaton 2075 Noise-Gain Analyzer including: purpose and function, equipment requirements, available options, specifications, and safety precautions.

1-3. PURPOSE AND USE OF EQUIPMENT

The 2075 Noise-Gain Analyzer is a programmable, microprocessor-controlled instrument designed specifically to make precise measurements of noise and gain characteristics of RF devices. The analyzer can be controlled in its local mode using its front panel controls, or in the remote mode, by an external controller via an IEEE-488 GPIB (General Purpose Interface Bus).

The analyzer can make the following measurements:

Corrected Noise Figure and Gain	(F + G)*
Uncorrected Noise Figure	(F)*
Corrected Effective Input Noise Temperature and Gain	$(T_e + G)$
Effective Input Noise Temperature	(T_e)
Corrected Effective Operating Noise Temperature and Gain	$(T_{op} + G)$
Effective Operating Noise Temperature	(T_{op})
Noise Measure (includes Gain)	(M)*
Y Factor	(Y)*
Power	(PWR dB)*
Excess Noise Ratio	(ENR)*

*Can be displayed in dB or as a dimensionless ratio

The specified input frequency range of the 2075 extends from 10 MHz to 1850 MHz. However, the unit is actually tunable and operable to 1900 MHz. In its simplest test configuration the analyzer will make measurements of RF devices with output frequencies in this range. More complex test configurations, requiring one or two stages of external downconversion, allow measurements of devices with output frequencies as high as 65.535 GHz. The 2075 has the capability for controlling the local oscillator used in the external downconversion process.

1-4. CALIBRATION CYCLE

At six month intervals the Performance Verification Procedures in Section 5 of this manual should be performed to ensure the continued optimum performance of the 2075.

At one year intervals the instrument should be fully calibrated using the alignment and adjustment procedures from the maintenance manual. These procedures should be performed by qualified personnel experienced in calibration and servicing of electronic instrumentation.

1-5. EQUIPMENT SUPPLIED

The items listed in Table 1-1 are furnished with the 2075 Noise-Gain Analyzer.

Table 1-1. Equipment Supplied

QTY.	DESCRIPTION	PART NO.
1	AC Power Cord, 2 meters	1-910166-001
1	External Relay Plug	1-910417-101
1	Fuse, 1.0 Amp, slow-blow (for 220V operation)	1-924000-019
1	Operation Manual	500783-385
1	Maintenance Manual	500783-386

1-6. EQUIPMENT REQUIRED BUT NOT SUPPLIED

One or more noise sources are required for operation of the 2075. The type needed depends on the user applications. Also, one or more GPIB cables are required to operate the 2075 if an external controller is used, or if the 2075 is used to control an external local oscillator. Noise sources and GPIB cables are listed in Table 1-2 under Optional Accessories.

In addition, filters, mixers, and one or two external local oscillators may be required if the Device Under Test is to be measured at frequencies above 1850 MHz. See Sections 3-10 through 3-18 to determine the proper setup and equipment requirements.

Test equipment is required for the performance of the Performance Verification Procedures. The required test equipment is listed in Table 5-1 of this manual.

1-7. OPTIONAL ACCESSORIES

Table 1-2 lists the optional accessories available for use with the 2075 Noise-Gain Analyzer. For further information, please contact an Eaton sales representative in your area.

NOTE

Item 23, the Slide Mount Kit, must be ordered with the original purchase of the 2075. This option cannot be added later unless the unit is returned to the factory.

Table 1-2. Optional Accessories

ITEM NO.	DESCRIPTION	MODEL NO.
1	Solid State Noise Source 10 MHz-1500 MHz	7615
2	Solid State Noise Source 1 GHz-12.4 GHz	7616
3	Solid State Noise Source 12.4 GHz-18 GHz	7617
4	Solid State Noise Source 1 GHz-18 GHz	7618
5	Solid State Noise Source 10 MHz-18 GHz	7618E
6	Solid State Noise Source 10 MHz-26.5 GHz	7626
7	Solid State Noise Source with isolator, 1.2 GHz-1.4 GHz	230450-2
8	Solid State Noise Source with isolator, 2.7 GHz-2.9 GHz	230450
9	System Noise Source (High ENR) 10 MHz-18 GHz (Custom Specifications)	7650
10	System Noise Source (High ENR) 10 MHz-18 GHz (Custom Specifications)	7660
11	Triggerable Power Supply for Gas Discharge Noise Sources	7175
12	Gas Discharge Noise Source 8.2 GHz-12.4 GHz, WR90 output	7052
13	Gas Discharge Noise Source 12.4 GHz-18 GHz, WR62 output	7091
14	Gas Discharge Noise Source 18 GHz-26.5 GHz, WR42 output	7053
15	Gas Discharge Noise Source 26.5 GHz-40 GHz, WR28 output	7096
16	Hot/Cold Noise Standard DC-9 GHz	7009
17	GPIB Cable, 1 Meter Length (IEEE-488)	1-998094-001
18	GPIB Cable, 2 Meter Length (IEEE-488)	1-998094-002
19	GPIB Cable, 4 Meter Length (IEEE-488)	1-998094-003
20	Maintenance Kit for Eaton 2075 (Extender Boards and Cables)	1-006586-001
21	Anti-Static Workstation	1-998484-001
22	Rack Mount Kit	Option 11
23	Slide Mount Kit (see note above) (Option 11 also required)	1-998725
24	PROM ENR Table (permanent storage of ENR data for noise source)	Ordered as option with noise source
25	RF connector on rear panel	Option 17

1-8. SPECIFICATIONS

Specifications for the 2075 are listed in Tables 1-3 and 1-4. Table 1-3 lists the basic specifications. Supplemental information consisting of non-warranted, nominal performance characteristics is listed in Table 1-4.

Table 1-3. Eaton 2075 Performance Specifications

PERFORMANCE CHARACTERISTIC	LIMIT	CONDITIONS
NOISE FIGURE MEASUREMENT:		
Range	0 to 30 dB	
Resolution	0.01 dB	
Uncertainty	±0.05 dB	1) Noise Figure 0 to 12 dB 2) Temperature +10 to +40 ° C 3) ENR of 5 to 18 dB
	±0.10 dB	1) Noise Figure >12 dB 2) Temperature <10 ° C >40 ° C
GAIN MEASUREMENT:		
Range	−20 dB to +50 dB	
Resolution	0.01 dB	
Uncertainty	±0.2 dB	
INPUT:		
Frequency Range	Specified parameters apply from 10 MHz to 1850 MHz. Unit is tunable and operable up to 1900 MHz	

Table 1-3. Eaton 2075 Performance Specifications (Continued)

PERFORMANCE CHARACTERISTIC	LIMIT	CONDITIONS
Frequency Resolution	1 MHz (test configurations 1 - 6) 0.1 MHz (test configuration 1 only)	
Tuning Accuracy	±(0.5 MHz + 0.005 times the tuned frequency ±3 MHz maximum	
Second Stage Noise Figure	7 dB +.001 dB/MHz	For input power levels below -40 dBm
Input SWR	<1.5:1	
Reflection Coefficient	<0.2	
Allowable Net External Gain	>75 dB	
ELECTROMAGNETIC COMPATIBILITY:		
Conducted and Radiated Emissions	MIL STD 461A, CISPR Publication 11, and Messempfaenger-Postverfuegung 526/527/79	Conducted and radiated interference complies with MIL STD 461A, Methods CE03 and RE02, CISPR Publication 11 (1975), and Messempfaenger Postverfuegung 526/527/79 (Kennzeichnung Mit F-Nummer/Funkschutzzeichen)
Conducted and Radiated Susceptibility	MIL STD 461A 1968	Conducted and radiated susceptibility meets the requirements of methods CS01, CS02, CS06, and RS03 (1 Volt/meter) of MIL STD 461A 1968
GENERAL:		
Noise Source Drive Voltage	28.0 volts + .05 V 1.0 volt	Noise Source ON at up to 100 mA peak Noise Source OFF
Line Voltage	100 VAC ± 10% 110 VAC ± 10% 220 VAC ± 10% 240 VAC ± 10%	48 to 66 Hz 48 to 66 Hz 48 to 66 Hz 48 to 66 Hz
Power Dissipation	200 VA maximum	
Operating Temperature	0 to 55 ° C	
Storage Temperature	−55 to +75 ° C	
Height	146 mm (5.75 in.)	5¼ in. vertical rack space
Width	425 mm (16.8 in.)	
Depth	354 mm (14.0 in.)	
Weight	11.5 kg (25.5 lbs.)	

Table 1-4. Supplemental Specifications

CHARACTERISTIC	NOMINAL OR TYPICAL VALUE
Bandwidth	5.0 MHz Noise Bandwidth
Maximum Safe Input Level	+20 dBm RF or ±20 VDC
External Relays Drive Voltages and Currents	+5 VDC , 5 VA maximum +15 VDC, 4.5 VA maximum +30 VDC, 15 VA maximum
Controller Functions	HP 8672A, HP 8350A, Wiltron 6600 Series Sweep Generators, General Format
ENR Tables Storage Capacity	3 Tables, each can store up to 31 frequencies with corresponding ENR values, plus 1 PROM table can store 1 ENR value for all frequencies (4 tables total). An additional, optional PROM table can be ordered with the noise source.
Frequency Display	Displays Frequency in MHz, 4 GPIB annunciators are: SRQ Service Request RMT Remote TALK Talk LISTEN Listen 4 Parameter Annunciators are: LO Local Oscillator RF Radio Frequency IF Intermediate Frequency ENTER Enter Frequency Prompt
Gain Display	Displays Gain and other values. The 8 Annunciators are: LOSS Gain is less than zero dB ENR Excess Noise Ratio T (F) Temperature in Fahrenheit T (C) Temperature in Centigrade T (K) Temperature in kelvins ENTER Enter Value Prompt dB Units are displayed in dB RATIO Units are displayed as Ratio
Noise Figure Display	Displays Noise Figure and other values. The 8 Annunciators are: F Noise Figure Y Y-Factor T_e(K) Effective Input Noise Temperature in kelvins dB PWR Power and ENR M Noise Measure T_{op} Operating Noise Temperature dB Units displayed are in dB RATIO Units displayed as Ratio
Analog Gain Meter	Analog Indicator for Gain. Variable range is set by entering upper and lower limits.

Table 1-4. Supplemental Specifications (Continued)

CHARACTERISTIC	NOMINAL OR TYPICAL VALUE
Analog Noise Meter	Analog Indicator for Noise Figure. Variable range is set by entering upper and lower limits.
Scope/Plotter Output Connectors X, Y, Z	Rear panel connectors supply drive signals for external oscilloscope or X-Y plotter. Variable range is set by entering upper and lower limits. Output voltage range is 0 to 6 volts for X and Y. Z axis output is positive going TTL, 0 to 5 volts signal for blanking the oscilloscope.
IF Output	- 25 dBm to - 55 dBm, 5 MHz Bandwidth
DET Output	.2 volts to approx. + 5 volts, high impedance output

1-9. SAFETY PRECAUTIONS

WARNING This symbol designates precautionary actions which must be followed to avoid the possibility of injury and death.

WARNING

1. If this instrument is to be energized via an auto-transformer for voltage reduction, make sure that the common terminal is connected to the earth pole of the power source.

2. The power cable plug shall be inserted into a socket outlet provided with a protective earth contact. The protective action must not be negated by the use of an extension cord without a protective conductor (ground).

3. Before switching on the instrument, the protective earth terminal of the instrument must be connected to the protective conductor of the power cord. This is accomplished by ensuring that the instrument's internal earth terminal is correctly connected to the instrument's chassis and that the power cord is wired correctly.

4. Whenever it is likely that the protection has been impaired, the instrument must be made inoperable and secured against any unintended operation.

5. Any interruption of the protective ground conductor inside or outside the instrument, or disconnection of the protective earth terminal is likely to make the instrument dangerous. Intentional interruption is prohibited.

6. Make sure that only fuses with the required rated voltage and current, and of the specified type (normal-blow, slow-blow) are used for replacement. The use of repaired fuses and the shortcircuiting of fuseholders must be avoided. Remove the line cord before changing fuses.

7. Any adjustment, maintenance, and repair of the opened instrument under voltage should be avoided as much as possible and, where inevitable, should be carried out only by a skilled person who is aware of the hazard involved.

8. Exercise extreme care when servicing the unit. High voltages are used.

9. Capacitors inside the instrument may still be charged even if the instrument has been disconnected from its source.

CAUTION This symbol designates precautionary actions which must be followed to avoid damage to all or part of the instrument.

CAUTION

1. Verify that the line voltage selector card on the rear panel is in the correct position before connecting the power.

2. Verify that the socket for the power line cord is provided with a protective earth contact.

3. Any interruption of the protective (grounding) conductor inside or outside the instrument is likely to cause damage to the instrument. To avoid damage, this instrument and all line powered devices connected to it must be connected to the same earth ground.

4. Make sure that only fuses with the required rating, and of the specified type, are used for replacement. Fuse ratings are given on the rear panel of the instrument near the fuseholder.

5. To avoid the possibility of damage to test equipment, read completely through each section before starting it. Make any preliminary control settings necessary for correct test equipment operation.

6. Do not torque the RF connector to more than 2½ inch-pounds.

SECTION 2

INSTALLATION

2-1. INTRODUCTION

This section of the manual contains information required for unpacking, inspecting, and installing the Eaton 2075 Noise-Gain Analyzer.

2-2. UNPACKING AND PHYSICAL INSPECTION

Examine the shipping carton for damage before unpacking the equipment. If the carton has been damaged, have the carrier's agent present when the equipment is removed from the carton. Retain the shipping carton and padding material for the carrier's inspection if damage to the equipment is evident after it has been unpacked.

CAUTION

> Exercise care when removing the instrument from its shipping container to ensure that no damage is incurred at this time.

See that the equipment is complete as listed on the packing slip. Visually examine the 2075 for any evidence of physical damage. If any damage is evident, or if the contents are not complete, immediately notify the carrier and also your local Eaton sales office. After completing the physical inspection, the Performance Verification Procedures in Section 5 of this manual should be performed as an operational or electrical inspection.

2-3. AC POWER REQUIREMENTS

Prior to shipping, the 2075 is configured to operate on 120 VAC, 60 Hz line power. The unit is easily reconfigured for operation using 100, 220, or 240 VAC. Refer to Figure 2-1 below and perform the following steps to verify, or to change, the line voltage configuration:

WARNING

> Observe all the safety precautions listed in paragraph 1-9. In particular, determine that the line voltage selector card is set to its correct position. If it is necessary to change the card setting, use the following procedure.

NOTE

> For units with serial numbers 286 and up, it makes no difference whether the unit is configured for 100 or 120 VAC. Likewise, it makes no difference whether the unit is configured for 220 or 240 VAC.

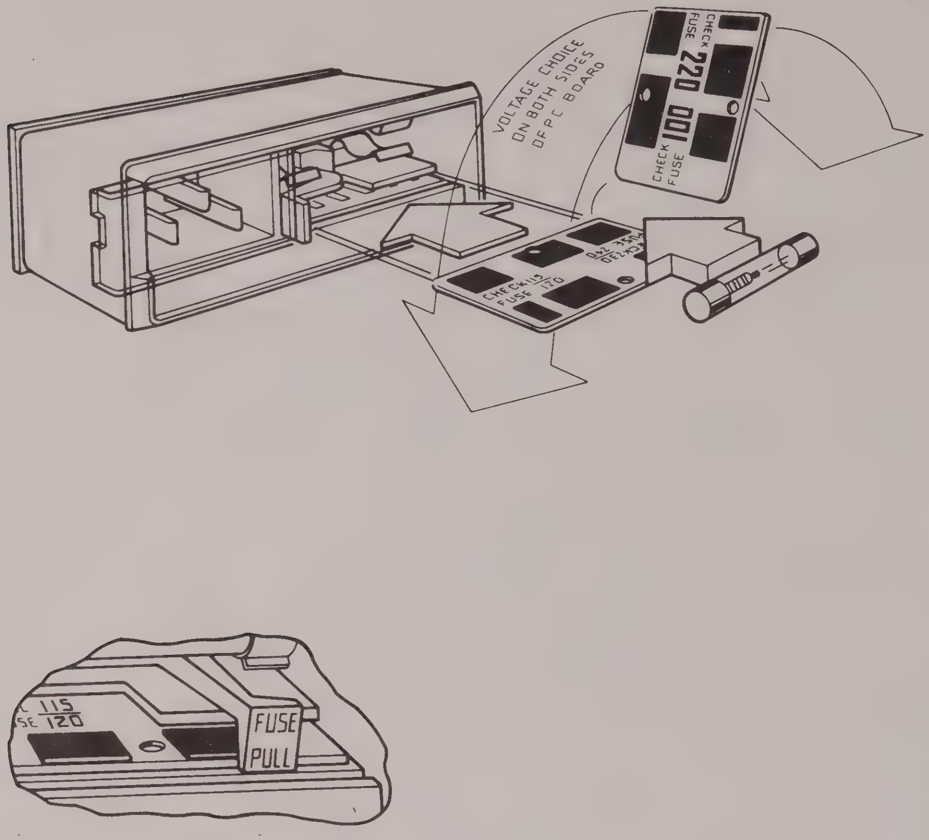


Figure 2-1. AC VOLTAGE SELECTION CARD

1. On the rear of the unit, locate the receptacle for the line power cord. The power cord should be unplugged from the receptacle.
2. Slide the transparent fuse cover to the left, and pull the FUSE PULL lever to remove the fuse.
3. Read the voltage level printed on the voltage selector card. (This number becomes visible after the fuse is removed.)
4. The unit is normally configured for 120 VAC operation. If the unit is to be operated using this line voltage, verify that this value is visible. Verify that the fuse rating is 2.0 Amps, slow-blow, and reinsert the fuse.
5. To reconfigure for operation at 100, 220, or 240 VAC, remove the voltage selector card. A small hole is provided in the card to accommodate a hook for easy removal.
6. Rotate the card so that the desired operating voltage is visible on its upper surface. Now position the card for reinsertion with the desired voltage on the outboard edge.
7. Reinsert the card. The desired voltage should be visible.
8. Replace the fuse after verifying that its rating is correct. For 100 or 120 VAC, use the 2.0 Amp slow-blow fuse. For 220 or 240 VAC, use the 1.0 Amp slow-blow fuse.
9. Slide the transparent fuse cover back into place.
10. Plug the power cord into the receptacle.

WARNING

The power line cord is a 3 wire assembly to ensure that the instrument chassis is connected to the main ground. Under no conditions is this ground lead to be interrupted, or a 2 wire extension cord to be used.

CAUTION

Observe all the safety precautions given in paragraph 1-9.

2-4. OPERATIONAL INSPECTION

After verifying that the 2075 is configured for the correct line voltage, the unit should be subjected to the Performance Verification Tests in Section 5 of this manual. After completion of these tests, the unit is ready for bench-top operation.

2-5. OPERATING TEMPERATURE

The 2075 is designed to operate within specified performance limits over an ambient temperature range extending from 0 to 55 degrees Centigrade. Operation outside this range for extended periods will result in degradation of electrical performance and eventual malfunction.

2-6. SELECTION OF RELAY DC VOLTAGE

The RELAY POWER connector on the 2075 front panel provides voltage to automatically energize external relays during Second Stage Calibration.

This voltage is jumper selectable and can be set to +5, +15, or +30 volts DC. It is set to +30 volts before the unit is shipped from the factory. Refer to Figure 2-2 and perform the following steps to select +5 or +15 volts DC.

CAUTION

Observe all the safety precautions given in paragraph 1-9 for protection of the instrument and of personnel.

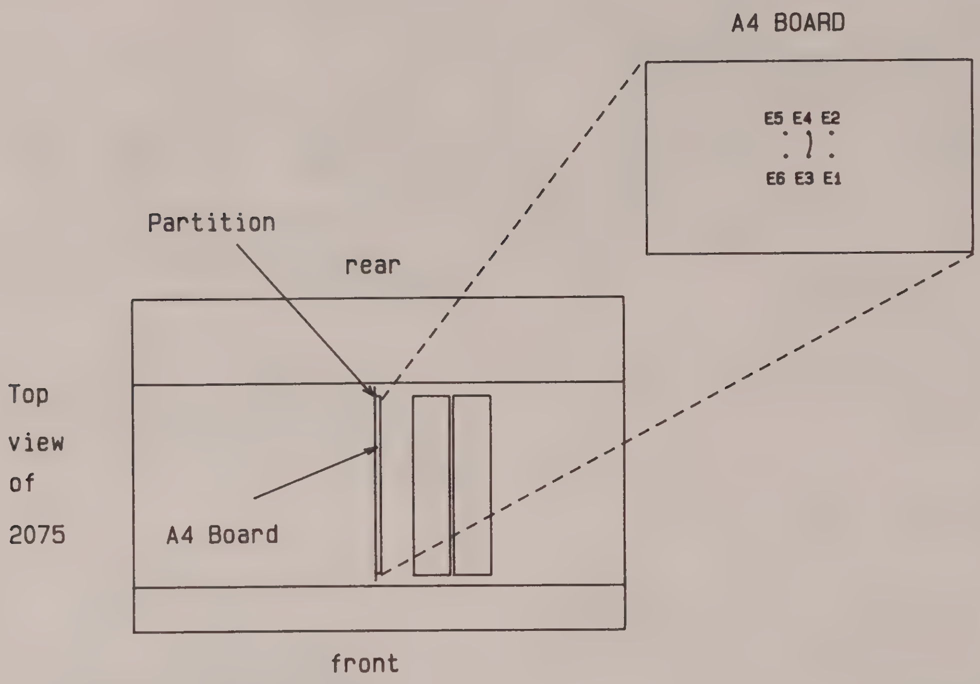


Figure 2-2. EXTERNAL RELAY VOLTAGE SELECTION

1. Remove the AC power cord from its receptacle on the rear of the 2075.
2. Remove the single 6-32 screw which secures the top cover panel. Slide the cover to the rear of the unit and remove it.
3. Two internal covers are exposed. Remove the nine 4-40 screws which secure the right side internal cover (the RF Deck Cover) and remove the cover.
4. Locate the A4 board. Its position is shown in Figure 2-2 above.
5. Remove the three board holding screws which are located along the top edge of the board.
6. Unplug the connectors located near the top edge of the board, as necessary, so that the board can be removed. Lift the board free of its edge connector.
7. Locate the pins E1 through E6. These are located in the center of the board as shown in Figure 2-2 above. A jumper is installed between pins E3 and E4, selecting +30 volts.
8. To select +5 volts, connect the jumper between pins E5 and E6. To select +15 volts, connect the jumper between pins E1 and E2.
9. To reassemble the unit perform steps 1 through 6 in reverse.

2-7. EQUIPMENT MOUNTING

The 2075 comes equipped with four supporting feet to allow bench-top operation. The unit may also be mounted in a standard 19 inch equipment rack on angled support brackets or on sliding mounts.

The rack mounting kit, Option 11, consists of two front panel brackets and the necessary screws for attaching the brackets to the 2075.

The Slide Mount Kit, part number 1-998725, consists of the two slide mount assemblies and the required mounting screws. Both kits are required for mounting the unit on slides. For rack mounting on angled brackets, only Option 11 is required.

NOTE

The Slide Mount Kit option must be ordered when the 2075 is originally purchased. The unit is shipped with the slide mounts installed.

2-8. RACK-MOUNTING THE 2075

Refer to Figure 2-3 to attach the rack mount brackets to the 2075. Refer to Figure 2-4 for installation of the 2075 on slide mounts in a standard equipment rack.

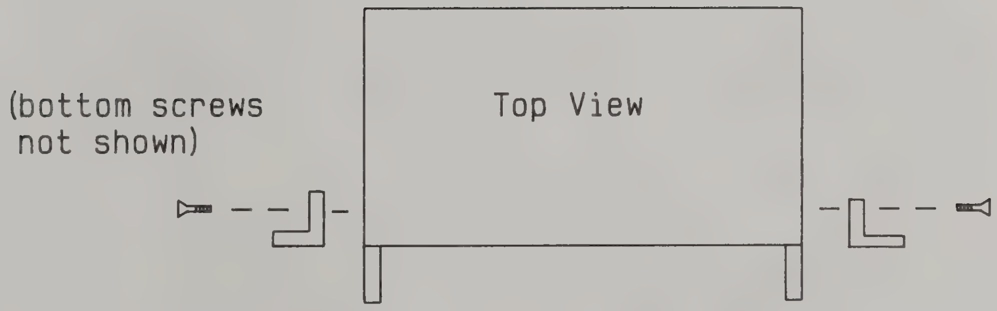
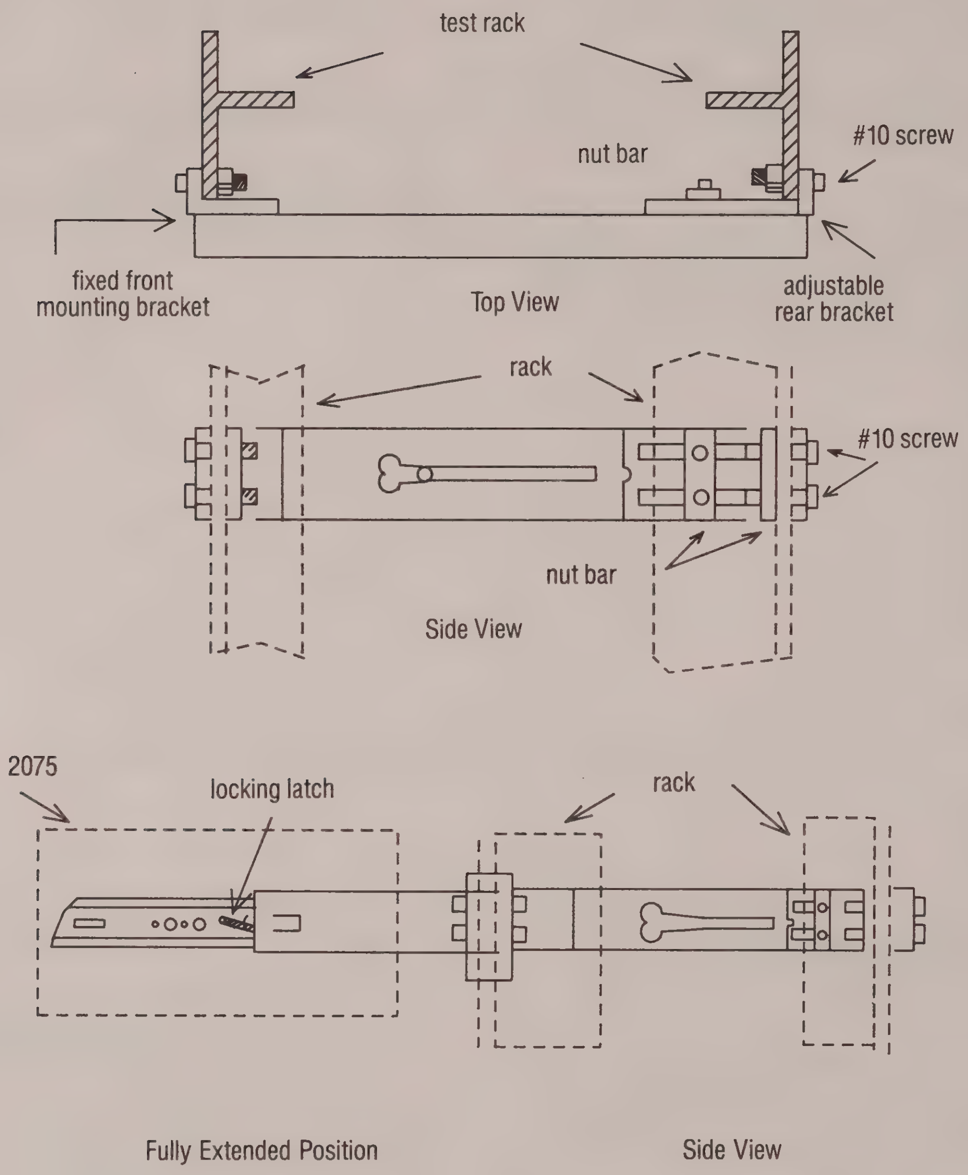


Figure 2-3. INSTALLATION OF RACK MOUNTS



To remove 2075 from rack or to push 2075 back into rack, lift locking latch first. Note that the adjustable bracket is the rear one.

NOTE: Slide mounts are manufactured by Grant Hardware Corporation, City of Industry, CA
Code No. 10003; P/N SS-168-NT-18

Figure 2-4. INSTALLATION OF SLIDE MOUNTS (Eaton P/N 1-998725-005)

2-9. EQUIPMENT INTERCONNECTIONS

Refer to Figure 3-2 and Table 3-2 for the locations and additional information on the rear panel connectors discussed below. The 2075 has three BNC-type connectors on its rear panel. These provide X, Y, and Z outputs which may be used to display data on an oscilloscope or analog X-Y Plotter. Install test cables between these outputs and the corresponding oscilloscope or plotter inputs if this function is to be utilized. When an oscilloscope is being used to display data, the INT (intensity) adjustment on the rear panel should be adjusted fully clockwise initially, and then adjusted to obtain the desired difference in intensity between the noise figure and gain traces. When an X-Y plotter is being used, the Z output should be connected to the plotter pen-lift input. Refer to paragraph 3-42 for the procedures detailing usage of these functions.

The IF OUT connector is provided on the rear panel of the 2075 to allow measurement or display of the 30 MHz IF signal. This signal is the result of the second stage of internal downconversion. Install a test cable between this BNC-type connector and an appropriate measurement device, if desired for test purposes.

The DET OUT connector is provided on the rear panel to allow measurement or display of the Final Detector Output voltage. Install a test cable between this BNC-type connector and an appropriate measurement device if desired for test purposes.

The line power receptacle on the Eaton 2075 rear panel is the input connector for AC power. Connect the line power cord to this receptacle.

A 24 pin GPIB connector is provided on the rear panel of the Eaton 2075. Connect the GPIB cable to this connector when using an external computer to control the Eaton 2075, when using the Eaton 2075 to control an external local oscillator, or when transmitting data to a printer. Figure 2-5 and Table 2-1 illustrate the GPIB connector pin layout.

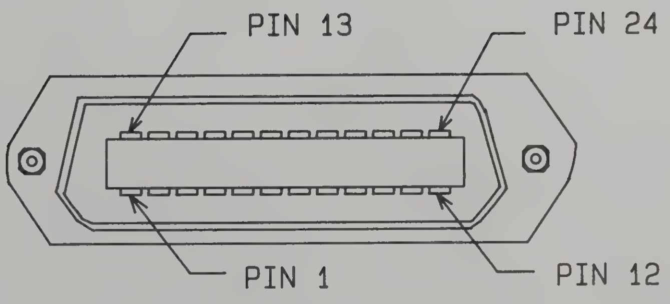


Figure 2-5. GPIB CONNECTOR

Table 2-1. GPIB Connector Pin-Out

PIN #	SIGNAL	PIN #	SIGNAL
1	DIO 1	13	DIO 5
2	DIO 2	14	DIO 6
3	DIO 3	15	DIO 7
4	DIO 4	16	DIO 8
5	EIO	17	REN
6	DAV	18	Signal Ground for pin 6
7	NRFD	19	Signal Ground for pin 7
8	NDAC	20	Signal Ground for pin 8
9	IFC	21	Signal Ground for pin 9
10	SRQ	22	Signal Ground for pin 10
11	ATN	23	Signal Ground for pin 11
12	SHIELD	24	Signal Ground for LOGIC

2-10. REFERENCE CARD

A quick reference pull-out card is located in the bottom of the 2075. This card summarizes information on special functions, test configurations, and error messages.

2-11. PRE-OPERATIONAL ADJUSTMENTS

The Performance Verification Procedures in Section 5 of this manual should be performed before making measurements with the 2075. These procedures constitute an operational or electrical inspection of a newly purchased unit and they can easily be performed in less than 10 minutes. Two of these procedures, the IF Attenuators Calibration (paragraph 5-6) and the Entry of Noise Source Calibration Data (ENR values and frequencies, part of paragraph 5-7) must be performed on a newly purchased unit prior to use.

No other pre-operational adjustments are required.

NATIONAL 42-381 50 SHEETS 5 SQUARE
42-382 100 SHEETS 5 SQUARE
42-389 200 SHEETS 5 SQUARE

SF 21.1

SF 12.1

SHIFT ON/OFF Enter Tcold °C

SF 14.1

START FREQ

STOP FREQ

STEP SIZE

CALIB

SF 14.0

SF 7.5 Read X_1 Y_1 (LL)

SF 7.6 Read X_2 Y_2 (UR)

Calculate $Y_2 - Y_1$ = RANGE 1
$X_2 - X_1$ = RANGE 3

Turn plotter ON & install paper

Select X & Y GRID DIVISIONS

Select QUADRANT I (Pg 3-19)

Select pen # 4

DRAW GRID

Set RANGE 1 & RANGE 3

Set new ZERO position by using SF 7.5 (LL) and using the ZERO cursor positioning arrows to set NF meter ZERO on GRID

Plotting
SF 7.7 NF SHIFT SWEEP
SF 7.8 G

SECTION 3

OPERATION

3-1. INTRODUCTION

This section of the manual contains information and procedures necessary to operate the Eaton 2075 Noise-Gain Analyzer. The 2075 is microprocessor-controlled using ROM resident firmware. It has an extremely wide range of capabilities and many of the front panel controls have multiple functions. This section of the manual is organized to simplify the process of learning how to operate the 2075, and to rapidly bring the new user to the process of making measurements.

Figure 3-1 and Table 3-1 show the front panel controls and indicators together with their functions and the corresponding keystroke sequences. Figure 3-2 and Table 3-2 show the rear panel controls and indicators together with their functions.

After inspecting and installing the 2075, use the procedure of paragraph 3-9 to enter ENR (Excess Noise Ratio) values. All necessary keystroke sequences are included in the procedure.

The 2075 is used in any of six different test configurations. The type of Device Under Test (DUT) and its output frequencies determine which test configuration is required. This section of the manual contains stand-alone procedures for making measurements in each possible test configuration. Paragraph 3-10 and Table 3-4 serve as a guide to selecting the needed configuration. Table 3-4 also directs the user to the paragraph containing the complete measurement procedure for the needed configuration. Each procedure includes the necessary steps, the control functions used, and the exact keystroke sequences to perform each function. These procedures are basic to making any automatic measurement.

The paragraphs following the test configuration procedures give detailed information on the various subjects relevant to usage of the 2075.

3-2. CAPABILITIES OF THE EATON 2075

The 2075 is fully compatible with the IEEE-488 General Purpose Interface Bus (GPIB). The instrument may be operated in any of three modes: LISTENER/TALKER, TALK ONLY, and LIMITED CONTROLLER.

In LISTENER/TALKER mode, an external controller controls the 2075 via an IEEE-488 GPIB. When the instrument is powered-up, it assumes this mode and is immediately addressable by the external controller. See Section 4 of this manual.

The TALK ONLY (TALK ALWAYS) mode is used to send measurement data to a GPIB compatible printer or other listener device. In this mode no external controller is used and all control of the 2075 is accomplished via the front panel.

The LIMITED CONTROLLER mode is the mode wherein the 2075 controls the frequency and power of a GPIB compatible, external signal source which is used as a local oscillator. The 2075 can use one of several ROM resident programs to control different models of signal sources. It also allows the user to write and enter a custom program via the front panel. No external controller is used while in this mode and all control of the 2075 is accomplished through the front panel.

In any mode, the 2075 can drive an oscilloscope, X-Y plotter, or strip chart recorder to display results of gain or noise measurements. For more information see paragraph 3-42, page 3-89.

The input frequency range of the 2075 extends from 10 MHz to 1850 MHz. In the most basic test configuration, measurements can be made for devices having output frequencies in this range. Through use of one or two stages of external downconversion, measurements can also be made at RF frequencies up to 65.535 GHz (test configurations 2 through 6). Sideband parameters are user selectable allowing measurements to be made single upper sideband, single lower sideband, or double sideband.

The 2075 can make FIXED FREQUENCY or SWEPT FREQUENCY measurements.

FIXED FREQUENCY is the default mode after power-on, and it is the mode in which measurements are made at a single frequency. Before and after measurements, manual frequency increment/decrement keys can be used to tune the frequency up or down in steps. The step size is user selectable. See paragraph 3-6, page 3-21.

In SWEPT FREQUENCY mode, START FREQUENCY, STOP FREQUENCY, and SWEPT FREQUENCY STEP SIZE are entered by the user. The maximum number of measurement points in this mode is equal to the frequency range width in MHz, divided by the maximum frequency resolution. For example, if the measurement range extends from 10 MHz to 1850 MHz, giving a range width of 1840 MHz, dividing 1840 by the maximum frequency resolution of .1 MHz, gives 18,400 measurement points. See paragraph 3-7, page 3-22.

Swept frequency mode is selected by initiating either a SINGLE SWEEP or CONTINUOUS AUTOMATIC SWEEPS.

SECOND STAGE CALIBRATION is the procedure wherein the 2075 measures the noise figure of the entire measurement system, excluding the Device Under Test (DUT). The calibration data obtained is used by the instrument when making corrected (First Stage) measurements of the DUT. During SECOND STAGE CALIBRATION the 2075 can store up to 100 calibration points. The number of calibration points and their frequencies are determined by the measurement frequency parameters entered by the user. See paragraph 3-34, page 3-75.

The 2075 can make uncorrected (cascade) measurements or corrected (first stage) measurements. A cascade measurement gives a single value which includes the noise of the Device Under Test (the first stage) combined with the noise of the measurement system (the second stage). No Second Stage Calibration is necessary before making cascade measurements.

A corrected, or first stage measurement, is essentially a cascade measurement from which the noise contribution of the measurement system has been subtracted. A Second Stage Calibration must be performed before making a corrected measurement.

After power-up, the 2075 is in the cascade measurement mode by default. Performing the Second Stage Calibration automatically places the instrument into the corrected measurement mode.

Three ENR tables allow the storage of Frequency/ENR values for up to 3 different noise sources. Each table can store the ENR data for up to 31 frequencies. A fourth table stores a single ENR value which can be used for all frequencies. A fifth table can be provided by an optional PROM chip which contains frequency and ENR values for a specific noise source. See paragraph 3-9, page 3-26, and paragraph 3-30, page 3-71.

The 2075 can make the following automatic measurements:

Noise Figure	(F)	(Cascade only)
Noise Figure and Gain (or Loss)	(F+G)	(Corrected only)
Effective Input Noise Temperature	(T_e)	(Cascade or corrected)
Y-Factor	(Y)	(Cascade only)
Operating Noise Temperature	(T_{op})	(Cascade or corrected)
Power	(dB)	(Cascade or corrected)*
Excess Noise Ratio	(ENR)	(Cascade or corrected)*
Noise Measure	(M)	(Corrected only)

*Cascade measurements are not recommended for these.

The following measurements can be made manually:

Corrected Noise Figure and Gain (or Loss)	(F+G)	See Paragraph 3-27, page 3-67.
Cascade Noise Figure	(F)	See Paragraph 3-27, page 3-67.
Y-Factor	(Y)	See Paragraph 3-28, page 3-69.

The 2075 can store its front panel control parameters for later retrieval and reuse. Nine sets of control parameters can be stored and then sequentially or randomly retrieved. The retrieval sequence is user programmable. See paragraph 3-48, page 3-110.

A number of special functions, each with multiple subordinate functions, extend the range of the instrument's available features beyond those of the dedicated front panel controls. See paragraph 3-46, page 3-101.

The 2075 displays error messages in the event of a procedural or hardware error. See paragraph 3-47, page 3-106.

Loss or gain compensation is available wherein the 2075 compensates for known losses or gains that cannot be included in Second Stage Calibration. See paragraph 3-40, page 3-86.

Laboratory ambient temperatures can affect the accuracy of noise measurements. The 2075 allows compensation for variations in the cold or off temperature of the noise source and thereby increases measurement accuracy. See Tcold Compensation, paragraph 3-41, page 3-88.

The bandwidth of the DUT, relative to the measurement system, can be a factor affecting measurement accuracy. The 2075 provides a method of compensating for bandwidth differences when the bandwidth of the DUT is less than the measurement bandwidth of the 2075. See Bandwidth Compensation, Paragraph 3-38, page 3-82.

The allowable external gain of the DUT is normally 50 dB. Because this parameter is bandwidth dependent, allowable external gain can be increased to as much as 70 dB. See paragraph 3-35, page 3-77.

3-3. CONTROLS AND INDICATORS

The controls and indicators, and their functions, are listed in Table 3-1.

Because the 2075 offers such a wide range of available functions, a single key may initiate two or more functions. The primary function of such a key is indicated by the key label or designation. For example, the key **START FREQ** is used to allow display or entry of the start frequency for a swept measurement. The primary function of a key is initiated by pressing that key once.

Where a key has a secondary function, this function is indicated by the orange lettering above or beside the key. For example, the key **START FREQ** has a secondary function which allows display or entry of an IF frequency from an external mixer. Accordingly, the orange designation, IF, is located just to the left of the key. The secondary, or shift function of a key is initiated by pressing the orange **SHIFT** key first, and then the function key. For example, to enter or display the IF frequency, press **SHIFT** and then **START FREQ.**

In addition to the primary and secondary functions, some keys have a tertiary function. The tertiary function of a key is specific to a particular mode of operation. While in that particular mode, pressing the function key initiates the tertiary function.

The 2075 front panel is designed so that where multiple keystrokes are required, the sequence is from left to right.

The keys of the numeric keypad are used for entry of numeric values. In all cases, the numeric entry is completed by pressing the **ENTER** key.

Table 3-1 lists the controls and indicators together with primary, secondary, and tertiary functions. The exact keystroke sequence for each function is also shown. Wherever functions or procedures are discussed in this manual, the applicable keystroke sequences are also included therein.

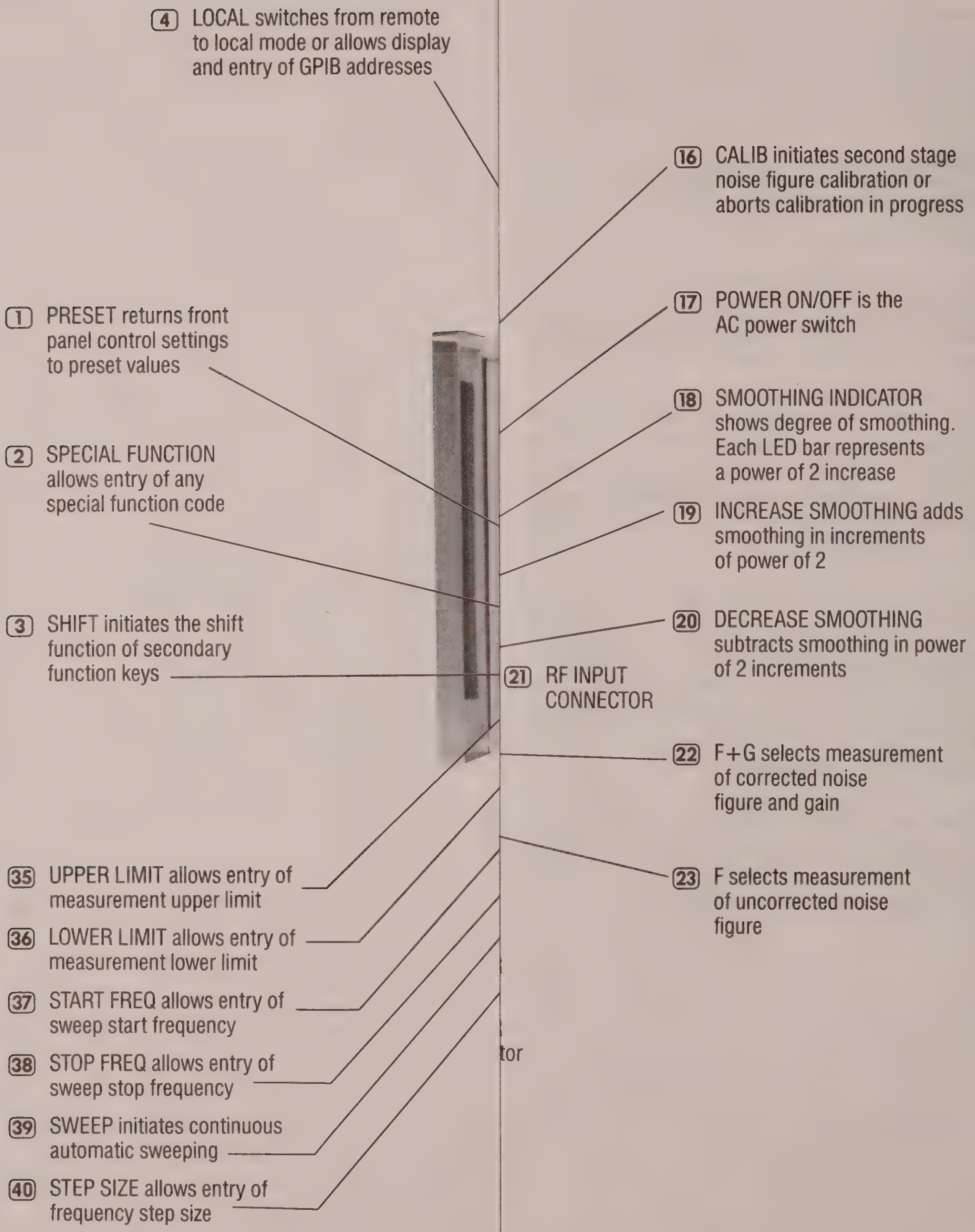
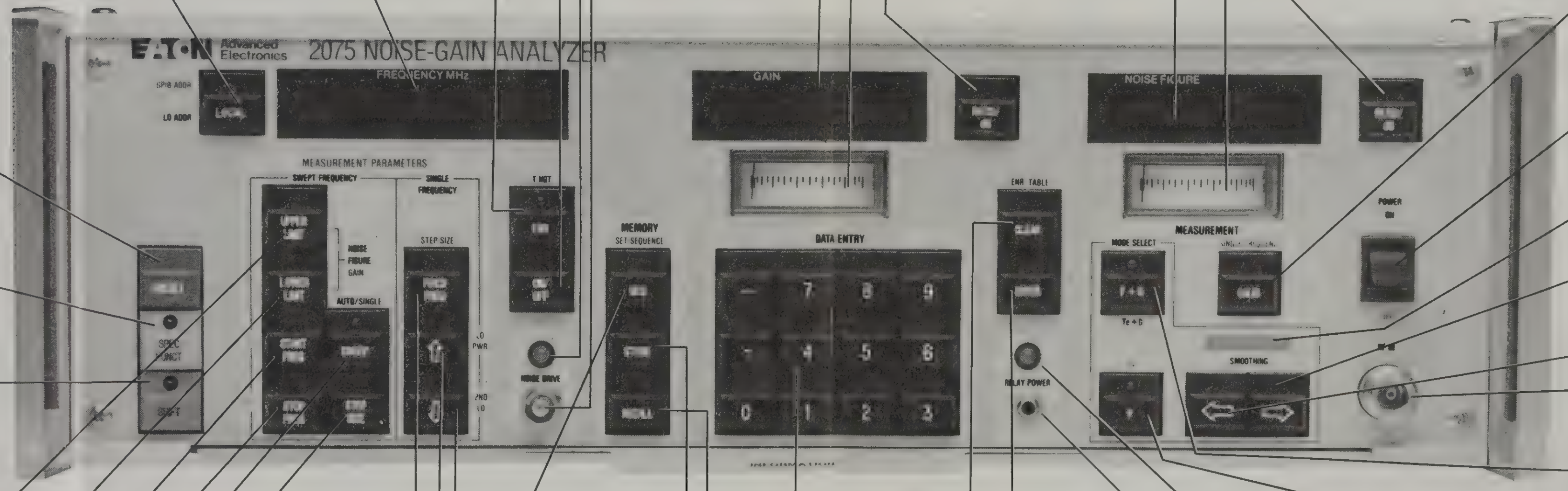

4 LOCAL switches from remote to local mode or allows display and entry of GPIB addresses
16 CALIB initiates second stage noise figure calibration or aborts calibration in progress
1 PRESET returns front panel control settings to preset values
17 POWER ON/OFF is the AC power switch
18 SMOOTHING INDICATOR shows degree of smoothing. Each LED bar represents a power of 2 increase
2 SPECIAL FUNCTION allows entry of any special function code
19 INCREASE SMOOTHING adds smoothing in increments of power of 2
3 SHIFT initiates the shift function of secondary function keys
20 DECREASE SMOOTHING subtracts smoothing in power of 2 increments
21 RF INPUT CONNECTOR
22 F+G selects measurement of corrected noise figure and gain
35 UPPER LIMIT allows entry of measurement upper limit
23 F selects measurement of uncorrected noise figure
36 LOWER LIMIT allows entry of measurement lower limit
37 START FREQ allows entry of sweep start frequency
38 STOP FREQ allows entry of sweep stop frequency
tor
39 SWEEP initiates continuous automatic sweeping
40 STEP SIZE allows entry of frequency step size

Figure 3-1. 2075 FRONT PANEL CON

Table 3-1. Front Panel Controls and Indicators

ITEM	DESIGNATION	FUNCTIONS AND KEYSTROKE SEQUENCES
1.	PRESET	Returns front panel control settings to preset values and stores current front panel control settings in memory register 0. Press: PRESET
2.	SPEC FUNC	Allows the entry of special function codes. To place the 2075 into any special function mode press: SPEC FUNC *numeric code* ENTER
		Allows viewing of the special function table to see which special functions are set to their default (.0) values or to some active state (.1, .2, .3, etc.). To enter the viewing mode, press: SPEC FUNC and use the **UP ARROW** and **DOWN ARROW** keys to move through the table.
		When already in this viewing mode, to change or enter a special function, enter the desired special function code by pressing: *numeric keys* ENTER This will also cause an exit from the viewing mode.
		To exit the special function table viewing mode without changing any settings, press: SPEC FUNC
3.	SHIFT	Initiates the shift function (secondary function) of the next key pressed. Press: SHIFT function key If the **SHIFT** key is pressed accidently, it can be deactivated by pressing it again.



① PRESET returns front panel control settings to preset values

② SPECIAL FUNCTION allows entry of any special function code

③ SHIFT initiates the shift function of secondary function keys

④ LOCAL switches from remote to local mode or allows display and entry of GPIB addresses

⑤ FREQUENCY DISPLAY shows frequencies in MHz (Window A)

⑥ ENR allows entry of ENR values into ENR tables

⑦ ON/OFF switches noise drive voltage on or off

⑧ NOISE DRIVE VOLTAGE **ON** Indicator

⑨ NOISE DRIVE Output Connector

⑩ GAIN DISPLAY displays Gain, ENR or Noise Temperature (Window B)

⑪ ANALOG GAIN METER

⑫ RATIO/dB selects units of Display for Gain Display

⑬ NOISE FIGURE DISPLAY displays Noise Figure, Y-Factor, Effective Noise Temperature, or Power

⑭ ANALOG NOISE FIGURE METER

⑮ RATIO/dB selects unit of display for NOISE FIGURE display

⑯ CALIB initiates second stage noise figure calibration or aborts calibration in progress

⑰ POWER ON/OFF is the AC power switch

⑱ SMOOTHING INDICATOR shows degree of smoothing. Each LED bar represents a power of 2 increase

⑲ INCREASE SMOOTHING adds smoothing in increments of power of 2

⑳ DECREASE SMOOTHING subtracts smoothing in power of 2 increments

㉑ RF INPUT CONNECTOR

㉒ F+G selects measurement of corrected noise figure and gain

㉓ F selects measurement of uncorrected noise figure

㉔ RELAY POWER **ON** Indicator

㉕ RELAY POWER Output Connector

㉖ DATA ENTRY KEYPAD for entry of numeric values

㉗ CLEAR clears front panel data keyed-in but not yet ENTERED

㉘ ENTER completes entry of numeric data

㉙ SEQ sequences through the front panel storage registers

㉚ STORE stores front panel control settings in storage registers

㉛ RECALL calls up stored control settings

㉜ FIXED FREQ allows entry of frequency for single frequency measurement

㉝ FREQUENCY INCREMENT MANUALLY

㉞ FREQUENCY DECREMENT MANUALLY

㉟ UPPER LIMIT allows entry of measurement upper limit

㊱ LOWER LIMIT allows entry of measurement lower limit

㊲ START FREQ allows entry of sweep start frequency

㊳ STOP FREQ allows entry of sweep stop frequency

㊴ SWEEP initiates continuous automatic sweeping

㊵ STEP SIZE allows entry of frequency step size

Figure 3-1. 2075 FRONT PANEL CONTROLS AND INDICATORS

Table 3-1. Front Panel Controls and Indicators

ITEM	DESIGNATION	FUNCTIONS AND KEYSTROKE SEQUENCES
1.	PRESET	Returns front panel control settings to preset values and stores current front panel control settings in memory register 0. Press: PRESET
2.	SPEC FUNC	Allows the entry of special function codes. To place the 2075 into any special function mode press: SPEC FUNC *numeric code* ENTER
		Allows viewing of the special function table to see which special functions are set to their default (.0) values or to some active state (.1, .2, .3, etc.). To enter the viewing mode, press: SPEC FUNC and use the **UP ARROW** and **DOWN ARROW** keys to move through the table.
		When already in this viewing mode, to change or enter a special function, enter the desired special function code by pressing: *numeric keys* ENTER This will also cause an exit from the viewing mode.
		To exit the special function table viewing mode without changing any settings, press: SPEC FUNC
3.	SHIFT	Initiates the shift function (secondary function) of the next key pressed. Press: SHIFT function key If the **SHIFT** key is pressed accidently, it can be deactivated by pressing it again.

Table 3-1. Front Panel Controls and Indicators (Continued)

ITEM	DESIGNATION	FUNCTIONS AND KEYSTROKE SEQUENCES
4.	LOCAL	Switches the 2075 from REMOTE to LOCAL mode except when local lockout is in effect. When in REMOTE press: LOCAL
		Allows the GPIB address of the 2075 to be displayed or a new address to be entered when in the LOCAL mode. When in the LOCAL mode press: LOCAL *numeric keys* ENTER
		Allows the GPIB address of an external local oscillator to be displayed or a new address to be entered. When in LOCAL mode only, press: SHIFT LOCAL *numeric keys* ENTER
5.	**FREQUENCY DISPLAY**	This LED display is also referred to as Window A. It displays the frequency, in MHz, of the function being performed. This display also has 8 annunciators. The 4 annunciators on the left refer to GPIB states. These are SRQ (service request), RMT (remote), TALK, and LISTEN. The four annunciators on the right are LO (local oscillator), IF (intermediate frequency), RF, and ENTER. A blinking ENTER annunciator signals the operator to enter a frequency value into an ENR table.
6.	ENR	Initiates the entry mode for ENR versus frequency values in the ENR versus frequency tables. Press this key once to initiate the entry mode. Press it again after all the entries have been made, to exit this mode. The lamp in the center of this key is lit while in the entry mode. Allows entry of the value for T_{hot} in kelvins. Press: SHIFT ENR
7.	ON/OFF	When operating in the manual measurement mode (normally used only with a true hot/cold thermal noise source), triggers a measurement. Press: ON/OFF
		Allows entry of the value for T_{cold}, in kelvins. Press: SHIFT ON/OFF *numeric keys* ENTER

Table 3-1. Front Panel Controls and Indicators (Continued)

ITEM	DESIGNATION	FUNCTIONS AND KEYSTROKE SEQUENCES
7.	ON/OFF (continued)	When Special Function 20.1 is in use, this key is used to display the ON voltage output from the Final Detector. If Special Function 20.2 is in use, pressing this key will display the OFF voltage output from the final detector. In either case, press: ON/OFF
8.	**NOISE DRIVE ON INDICATOR**	When operating in the manual measurement mode (normally used only with a true hot/cold thermal noise source), this lamp lights to tell the operator what measurement phase is being taken or has just been completed. **ON = hot, OFF = cold.** This indicator is not functional in the automatic measurement mode unless enabled by Special Function 21.1.
9.	**NOISE DRIVE CONNECTOR**	Supplies +28.00 volts DC drive voltage for a solid state calibrated noise source.
10.	**GAIN DISPLAY**	This display is also referred to as Window B. It displays Gain (G) or loss, ENR values, and temperature values entered by the user. Gain, loss, and ENR values may be displayed in dB or as ratios. Temperatures may be displayed as kelvins, degrees Centigrade, or degrees Fahrenheit. The eight annunciators in this display are LOSS, ENR, T(degrees F), T(degrees C), dB, RATIO, T(K), and ENTER. The ENTER annunciator blinks when the user is required to enter an ENR value.
11.	**ANALOG GAIN METER**	Is an analog indicator for Gain. The meter range is set by entering upper and lower meter limits for Gain. See items 35 and 36 of this table.
12.	RATIO/ dB	Changes the Window B unit of display for Gain or ENR from dB to a ratio or vice versa. An annunciator in the display shows which display unit is selected. Press: RATIO/ dB
13.	**NOISE FIGURE DISPLAY**	This display is also referred to as Window C. It displays Noise Figure, Y Factor, Effective Input Noise Temperature, Power Noise Measure, and Operating Noise Temperature. Noise Figure, Noise Measure, Y-Factor, and Power may be displayed as dB or as a ratio, depending on the unit of display selected. The eight annunciators in this display are F, Y, T_e(K), dB PWR, dB, RATIO, M, and T_{op}(K).

Table 3-1. Front Panel Controls and Indicators (Continued)

ITEM	DESIGNATION	FUNCTIONS AND KEYSTROKE SEQUENCES
14.	**ANALOG NOISE METER**	Is an analog indicator for noise figure. The meter range is set by entering upper and lower limits for the measurement desired. See items 35 and 36 of this table.
15.	RATIO/ dB	Changes the Window C unit of display from dB to a ratio or vice versa. An annunciator in the display indicates which is selected. Press: RATIO/ dB
16.	CALIB	Initiates an FCAL (frequency calibration) if Special Function 15.0 is enabled, and then a second stage calibration of the 2075. During second stage calibration the 2075 measures its own noise figures at different frequencies and stores these values for later use during corrected noise figure and gain measurements. Press: CALIB
		This key also is used to abort a calibration in progress. Press: CALIB
		Initiates a second stage calibration at the single fixed frequency to which the 2075 is currently tuned. Press: SHIFT CALIB
17.	**POWER ON/ OFF SWITCH**	Applies line voltage to the 2075 when the switch is set to ON.
18.	**SMOOTHING INDICATOR**	Shows the degree of smoothing currently in use. Each lit LED bar indicates a power of 2 increase in the smoothing factor. Smoothing factor is equal to the number of readings taken and averaged before the measurement is displayed when in the swept mode. Exponential smoothing is used during single frequency measurements.
19.	⇨	Adds smoothing in increments equal to powers of 2. Press or hold: ⇨

Table 3-1. Front Panel Controls and Indicators (Continued)

ITEM	DESIGNATION	FUNCTIONS AND KEYSTROKE SEQUENCES
20.	⇦	Subtracts smoothing in decrements equal to powers of 2. Press or hold: ⇦
21.	**RF INPUT CONNECTOR**	Is the 2075 input connector.
22.	F+G	Initiates measurement of corrected Noise Figure and Gain. Press: F+G *
		Initiates measurement of corrected T_e (Effective Noise Temperature) and Gain. Press: SHIFT F+G *
		*Requires prior Second Stage Calibration
23.	F	Initiates measurement of uncorrected Noise Figure. Press: F
		Initiates measurement of uncorrected T_e (Effective Noise Temperature) in kelvins. Press: SHIFT F
24.	**RELAY POWER ON INDICATOR**	This green lamp lights to indicate that the selected relay power voltage is present at the RELAY POWER OUTPUT CONNECTOR. This voltage is automatically turned on when the **CALIB** key is pressed.
25.	**RELAY POWER CONNECTOR**	This output connector provides a jumper selectable DC voltage of +5, +15, or +30 volts which may be used to actuate external relays. The external relays are used to bypass the DUT (Device Under Test) during Second Stage Calibration.

Table 3-1. Front Panel Controls and Indicators (Continued)

ITEM	DESIGNATION	FUNCTIONS AND KEYSTROKE SEQUENCES
26.	**DATA ENTRY KEYPAD 0-9, -, .**	Used to enter numeric data for various instrument functions. Digits keyed-in are displayed but do not become effective until the **ENTER** key is pressed. Press: *numeric data keys* ENTER
27.	CLEAR	Clears all numeric data which has been keyed-in but not yet terminated with the **ENTER** key. After the unwanted or erroneous numerics have been keyed-in, press: CLEAR
		When in the ENR versus Frequency entry mode, clears the Frequency/ENR pair currently displayed. Press: CLEAR
		When in the ENR versus Frequency entry mode, clears the table in use. Press: SHIFT CLEAR
28.	ENTER	Completes all numeric data entries. Numeric data which has been keyed-in does not take effect until this key has been pressed. Press: *numeric keys* ENTER
		When entering frequency and ENR values this key can be used to toggle the blinking ENTER annunciator back and forth between Window A and Window B. The ENTER annunciator indicates which value must be entered next, frequency or ENR. Press: ENTER
29.	SEQ	Causes sequential stepping through nine (1-9) of the ten front panel storage registers. The number of each register is displayed as it becomes available for access. These registers store front panel control settings for later recall and reuse. See paragraph 3-47. Press: SEQ ENTER

Table 3-1. Front Panel Controls and Indicators (Continued)

ITEM	DESIGNATION	FUNCTIONS AND KEYSTROKE SEQUENCES
29.	SEQ (continued)	Allows reprogramming of the stepping sequence through the 9 front panel storage registers. Key-in the entire new sequence before pressing the **ENTER** key. Press: SHIFT SEQ *numeric keys* ENTER
30.	STORE	Causes the current front panel control settings to be stored in 1 of the 9 front panel storage registers. Press: STORE *numeric key* ENTER
31.	RECALL	Causes a set of previously stored front panel control settings to be recalled from any of the 10 storage registers and made active. Press: RECALL *numeric key* ENTER
		Continues a sweep which was stopped in progress, from the point at which it was stopped. See item 39 of this table. Press: SHIFT RECALL
32.	FIXED FREQ	Allows entry of a fixed frequency to be used for a single frequency measurement. Press: FIXED FREQ *numeric keys* ENTER
		Allows entry of the frequency step size for manual frequency incrementing only. (If the frequency step size for automatic continuous sweeps or single sweeps is changed, using item 40 of this table, the manual frequency incrementing step size will automatically change to that same value.) SHIFT FIXED FREQ *numeric keys* ENTER
33.	⇧	Causes frequency to step upward when in the fixed frequency mode. Also causes frequency to increment when viewing Frequency versus ENR tables. Press or hold: ⇧

Table 3-1. Front Panel Controls and Indicators (Continued)

ITEM	DESIGNATION	FUNCTIONS AND KEYSTROKE SEQUENCES
33.	⇧ (continued)	Causes incrementing through the special functions table when in the special functions viewing mode. See item 2 of this table. Press or hold: ⇧
		Allows entry of a signal amplitude (in dBm only) for an external local oscillator. Press: SHIFT ⇧ *numeric keys* ENTER
34.	⇩	Causes frequency to step downward when in the fixed frequency mode. Also causes frequency to decrement when viewing the Frequency versus ENR tables. Press or hold: ⇩
		Causes decrementing through the special functions table when in the special functions viewing mode. Press or hold: ⇩
		Allows entry of the Second Local Oscillator frequency used in DUT (Device Under Test) Configuration 6. Press: SHIFT ⇩ *numeric keys* ENTER
35.	UPPER LIMIT	Allows entry of the upper limit for Window C measurements. The minimum upper limit allowed is -30 and the maximum upper limit allowed is 9999. The value entered is used by the 2075 only to set the range of the ANALOG NOISE METER and to set the range for the SCOPE/PLOTTER OUTPUT. Press: UPPER LIMIT *numeric keys* ENTER

Table 3-1. Front Panel Controls and Indicators (Continued)

ITEM	DESIGNATION	FUNCTIONS AND KEYSTROKE SEQUENCES
35.	UPPER LIMIT (continued)	Allows entry of the upper limit for Gain. The maximum allowable upper limit is 80 dB and the minimum allowable upper limit is -30 dB. This value is used by the 2075 to set the ranges for the ANALOG GAIN METER and the SCOPE/PLOTTER OUTPUT. Press: SHIFT UPPER LIMIT *numeric keys* ENTER
36.	LOWER LIMIT	Allows entry of the lower limit for measurements displayed in Window C. The minimum allowable lower limit is -30. The maximum allowable lower limit is 9999. The value entered is used by the 2075 only to set the range of the ANALOG NOISE METER and to set the range for the SCOPE/PLOTTER OUTPUT. Press: LOWER LIMIT *numeric keys* ENTER
		Allows entry of the lower limit for Gain. The minimum allowable lower limit is -30 dB. The maximum allowable lower limit is 80 dB. The value entered is used by the 2075 only to set the ranges for the ANALOG GAIN METER and the SCOPE/PLOTTER OUTPUT. Press: SHIFT LOWER LIMIT *numeric keys* ENTER
37.	START FREQ	Allows entry of the start frequency for frequency sweeps. Press: START *numeric keys* ENTER
		Causes the 2075 to tune to the current start frequency value. The previous value for fixed frequency is lost and replaced with this current start frequency value. Press: START FREQ
		Allows entry of the IF frequency from the external mixer when external downconversion is required in test configurations 2, 4, and 6. The IF frequency is the input frequency to the 2075. Press: SHIFT START FREQ *numeric keys* ENTER

Table 3-1. Front Panel Controls and Indicators (Continued)

ITEM	DESIGNATION	FUNCTIONS AND KEYSTROKE SEQUENCES
38.	STOP FREQ	Allows entry of the stop frequency for frequency sweeps. Press: STOP FREQ *numeric keys* ENTER
		Causes the 2075 to tune to the current value for stop frequency. The previous value for fixed frequency is lost and replaced with this current stop frequency value. Press: STOP FREQ
		Allows entry of a fixed Local Oscillator frequency when external downconversion is required (DUT Test Configurations 2-6). Press: SHIFT STOP FREQ *numeric keys* ENTER
39.	SWEEP	Initiates continuous automatic sweeps from start frequency to stop frequency. Each sweep is composed of incremental frequency steps across the band. Press: SWEEP
		Stops a sweep in progress and leaves the 2075 tuned to the frequency at which the sweep was stopped. See item 31 in this table. Press: SWEEP
		Initiates a single sweep from the start frequency to the stop frequency. Press: SHIFT SWEEP
40.	STEP SIZE	Allows entry of the incremental frequency step size for automatic continuous or single sweeps (.1 MHz minimum). Entering this value will also change the step size for manual frequency incrementing or decrementing. Press: STEP SIZE *numeric keys* ENTER

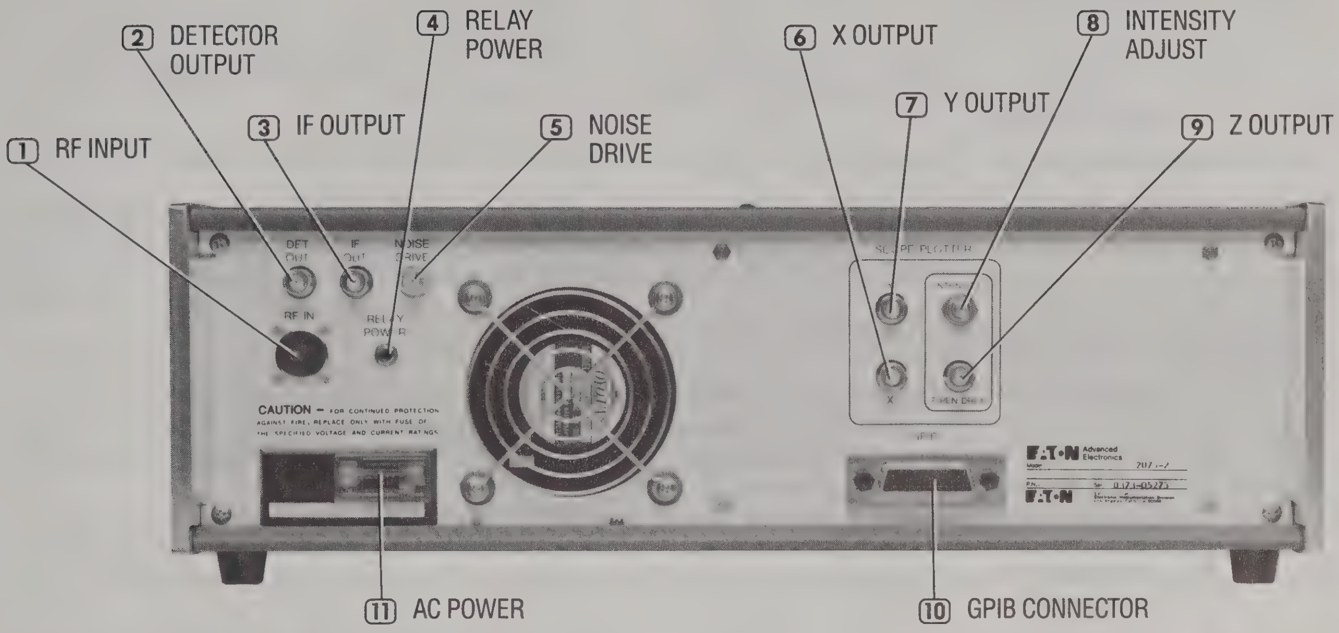


Figure 3-2. 2075 REAR PANEL

Table 3-2. Rear Panel Controls and Indicators

ITEM	DESIGNATION	FUNCTION
1.	**RF INPUT CONNECTOR**	This RF INPUT connector on the rear panel is optional when ordering the 2075. It is also possible to remove the front panel RF INPUT connector and install it on the rear panel. The internal semi-rigid coaxial cable can be reshaped to make the necessary connection.
2.	**DET OUT**	This BNC connector is the test output for the Final Detector output voltage.
3.	**IF OUT**	This BNC connector is the test output for the 30 MHz signal which is the result of the second stage of internal downconversion in the 2075.
4.	**RELAY POWER CONNECTOR**	This output connector provides a jumper selectable DC voltage of +5, +15, or +30 volts which may be used to actuate external relays. The external relays are used to bypass the DUT during Second Stage Calibration. This connector parallels the RELAY POWER connector on the front panel.

Table 3-2. Rear Panel Controls and Indicators (Continued)

ITEM	DESIGNATION	FUNCTION
5.	**NOISE DRIVE CONNECTOR**	Supplies +28.00 volts DC for the solid state calibrated noise source. Parallels the NOISE DRIVE connector on the front panel.
6.	**X OUTPUT**	This BNC connector is the output for the horizontal drive signal to the scope/plotter X axis. The X axis drives for both gain and noise figure traces are output alternately. The sawtooth waveform minimum and maximum voltages are 0 and 6 volts respectively.
7.	**Y OUTPUT**	This BNC connector is the output for the scope/plotter Y axis. The Y axis drives for both gain and noise data are output singly or alternately depending on the setting of Special Function 7. The minimum and maximum voltages are 0 and 6 volts respectively.
8.	**INTENSITY ADJUST**	This adjustment controls the brightness of the gain and noise figure traces on the oscilloscope.
9.	**Z OUTPUT**	This BNC connector is the output for the scope/plotter Z axis. This positive going signal blanks the oscilloscope during retrace or activates the pen lift on the plotter. It also decreases the intensity for the gain trace. When both gain and noise figure are being displayed on an oscilloscope, the noise trace is the brighter one. The signal minimum and maximum voltages are 0 and 5 volts.
10.	**GPIB**	This 24 pin connector is the input/output connector for the General Purpose Interface Bus (IEEE-488). Pin numbers are illustrated in Figure 2-5.
11.	**AC POWER**	This is the receptacle for the AC power cord, the holder for the AC fuse, and the receptacle for the AC voltage selector card.

3-4. POWER-ON CONDITIONS, PRESET, AND TOTAL SYSTEM RESET

Power-On Conditions

When the 2075 is powered-on, it automatically performs a series of self-tests. These check the operation of the Math Processor, RAM's, ROM's, GPIB Controller Chip, the Direct Memory Access Controller (DMAC), and the Scope/Plotter Output Interface. Finally, the instrument performs a Frequency Calibration (FCAL) which ensures the accuracy of its frequency tuning. Immediately after placing the POWER switch in the ON position, the following correct indications will be observed:

1. All front panel red LED's and indicators light briefly.
2. The words SELF TEST appear in Windows A and B while the numbers 1 through 6 appear sequentially in Window C.
3. The message FCAL appears briefly in Window B.

When the frequency calibration is completed, the instrument restores the frequency and control parameters it had before it was last powered-off, except for the following:

The instrument is in LOCAL mode.

The instrument is in Fixed Frequency Mode and is tuned to the last frequency set prior to power-down.

The measurement mode is Uncorrected (Cascade) Noise Figure.

The instrument is in the Continuous Measurement Mode (it is continuously making measurements).

Previous Second Stage Calibration data is lost.

The SRQ (Service Request) function is disabled.

Some special functions are restored to their previous values and others revert to their default or .0 state. For a complete listing of power-on control parameters see Column 2 of Table 3-3.

Preset

The **PRESET** key can be pressed at any time to restore certain of the control parameters to known preset values. This feature is typically used after a power-on or when previous control parameters are unknown. Some parameters and special functions are not affected by the PRESET function and will remain in their previous states. See Column 3 of Table 3-3 for a complete list of PRESET parameter values.

Total System Reset

This is a special function which erases all previous frequency and control parameters including ENR tables. After the parameters are erased, some are automatically replaced with values from ROM. This special function is typically used as a security measure after confidential measurements have been made. It should also be performed after the 2075 has been unused for a long enough period of time that the data in battery backed-up RAM may be unreliable. To do a Total System Reset press:

SPEC FUNC   0.9   ENTER

After the system reset, an IF Attenuator Calibration (Special Function 19.1) must be performed. See paragraph 3-36, page 3-78.

Column 4 of Table 3-3 shows what control parameter values are in effect after the total system reset is performed.

Column 5 of Table 3-3 shows which control parameters can be stored in the STORE-RECALL registers (paragraph 3-48, page 3-110).

Table 3-3. Power-On, Preset, and Total System Reset Parameters

This is a listing of all the control parameters and special functions settings which are in effect after a Power-up, Preset, or Total System Reset via Special Function 0.9. The last column shows which control parameters can be stored in the Store-Recall registers.

PARAMETER	POWER ON	PRESET or DEVICE CLEAR	TOTAL SYSTEM RESET (SP FN 0.9)	STORABLE IN REGISTERS
INPUT PARAMETERS				
Tuned Frequency	N.C.	30 MHz	30 MHz	YES
Start Frequency	N.C.	10 MHz	10 MHz	YES
Stop Frequency	N.C.	1900 MHz	1900 MHz	YES
Swept Frequency Step Size	N.C.	20 MHz	20 MHz	YES
Fixed Frequency Step Size	N.C.	20 MHz	20 MHz	YES
Fixed Frequency Step Size	N.C.	20 MHz	20 MHz	YES
Ext LO 1 Frequency	N.C.	1000 MNz	1000 MHz	YES
Ext LO 2 Frequency	N.C.	1000 MHz	1000 MHz	YES
Int IF Frequency	N.C.	30 MHz	20 MHz	YES
LO Settling Time	N.C.	N.C.	100 msec	
LO Power Level	N.C.	0 dBm	0 dBm	YES
RF Frequency	N.C.	N.C.	10 MHz	
RF Start Frequency	N.C.	N.C.	10 MHz	
RF Stop Frequency	N.C.	N.C.	1900 MHz	
RF Sweep Delta	N.C.	N.C.	20 MHz	
RF Step Size	N.C.	N.C.	20 MHz	
SCOPE/PLOTTER PARAMETERS:				
Noise Upper Limit	30	30	30	YES
Noise Lower Limit	0	0	0	YES
Gain Upper Limit	80 dB	80 dB	80 dB	YES
Gain Lower Limit	-20 dB	-20 dB	-20 dB	YES
LOSS COMPENSATION PARAMETERS:				
Loss Before DUT	0 dB	0 dB	0 dB	
Loss After DUT	0 dB	0 dB	0 dB	
Temperature of Losses	290 k	290 k	290 k	
BANDWIDTH COMPENSATION PARAMETERS:				
Bandwidth 1	5 MHz	5 MHz	5 MHz	
Bandwidth 2	5 MHz	5 MHz	5 MHz	
ENR Table Selection (sp fn 5)	N.C.	N.C.	TABLE 0	
ENR Tables	N.C.	N.C.	CLEAR ALL	
Nom ENR Value	N.C.	N.C.	15.5 dB	
T_{Hot} Entry	9893 k	N.C.	9893 k	YES
T_{Cold} Entry	296.0 k	N.C.	296.0 k	

N.C. = no change from previous set value

Table 3-3. Power-On, Preset, and Total System Reset Parameters (Continued)

PARAMETER	POWER ON	PRESET or DEVICE CLEAR	TOTAL SYSTEM RESET (SP FN 0.9)	STORABLE IN REGISTERS
BANDWIDTH COMPENSATION PARAMETERS (Continued):				
IF Calibration Data	SAVED	SAVED	CLEARED	
Second Stage Calibration Data	CLEARED	CLEARED	CLEARED	
Store/Recall Registers	SAVED	SAVED (and the current front panel is saved in register 0)	CLEARED	
Set Sequence	SAVED	SAVED	CLEARED	
SPECIAL FUNCTIONS:				
1	N.C.	1.1	1.1	YES
2	N.C.	2.0	2.0	YES
3	N.C.	3.0	3.0	
4	4.0	4.0	4.0	
5	N.C.	N.C.	5.0	YES
6	6.0	6.0	6.0	
7	(7.2 OR 7.6)		7.2	
8	8.0	8.0	8.0	
9	N.C.	9.0	9.0	
10	10.0	10.0	10.0	
11	11.1*	11.0	11.0	
12	N.C.	12.0	12.0	
13	13.1*	13.0	13.0	
14	14.0	14.0	14.0	
15	15.0	15.0	15.0	
16	16.1	16.1	16.1	
17	17.0	17.0	17.0	
18	18.0	18.0	18.0	
19	19.0	19.0	19.0	
20	20.0	20.0	20.0	
21	21.0	21.0	21.0	
22	22.0	22.0	22.0	
23	23.0	23.0	23.0	
24	N.C.	24.0	24.0	
30	30.0	30.0	30.0	
31	31.0	31.0	31.0	
32	32.0	32.0	32.0	
33	33.0	33.0	33.0	

* = is set to this value but is not active

Table 3-3. Power-On, Preset, and Total System Reset Parameters (Continued)

PARAMETER	POWER ON	PRESET or DEVICE CLEAR	TOTAL SYSTEM RESET (SP FN 0.9)	STORABLE IN REGISTERS
SPECIAL FUNCTIONS (Continued):				
34	34.0	34.0	34.0	
35	35.0	35.0	35.0	
36	36.0	36.0	36.0	
37	37.0	37.0	37.0	
38	38.0	38.0	38.0	
39	39.0	39.0	39.0	
40	40.0	40.0	40.0	YES
42	42.0	42.0	42.0	
43	43.0	43.0	43.0	
44	44.0	44.0	44.0	
45	45.0	45.0	45.0	
46	46.0	46.0	46.0	
47	N.C.	N.C.	47.0	YES
48	48.0	48.0	48.0	
49	N.C.	49.0	49.0	

* = is set to this value but is not active

3-5. CONTINUOUS MEASUREMENT MODE AND THE HOLD FUNCTION

After the 2075 completes its power-on sequence, it goes into the Continuous Measurement Mode which is its normal mode. While in this mode, fixed frequency measurements are made at a maximum rate of 11 times per second, at the current tuned frequency.

While the user enters the various control and frequency parameters prior to making the desired measurement, the instrument will continue to make measurements in this continuous mode. Thus, measurements will be made before a complete and consistent set of parameters can be entered by the user. This may result in error messages.

A HOLD function is provided which takes the instrument out of continuous measurement mode and prevents this situation. This is a special function. To activate HOLD press:

SPEC FUNC | 14.1 | ENTER

GPIB: T1

After all the control and frequency parameters have been entered the HOLD function should be deactivated. To deactivate HOLD and restore the instrument to continuous measurement mode, press:

SPEC FUNC | 14.0 | ENTER

GPIB: T0

3-6. FIXED FREQUENCY OPERATION

In the Fixed Frequency Mode the 2075 makes measurements at a single frequency. The instrument is in this mode after power-on until a Swept Frequency Mode is selected by the user.

Fixed Frequency Value

The **FIXED FREQ** key is used to display the current fixed frequency or to enter a new fixed frequency value. Entering a fixed frequency value tunes the 2075 to that frequency. In Test Configurations 1 and 4, the allowable frequency entries are 10 MHz to 1900 MHz. In Test Configurations 2, 3, 5, and 6, the allowable entries are 10 MHz to 65.535 GHz.

To enter a Fixed Frequency value (for example, 1600 MHz) press:

FIXED FREQ | 1600 | ENTER .

GPIB: FF1600MZ

Fixed Frequency Step Size

In the Fixed Frequency Mode a Fixed Frequency Step Size may be entered and then used for manual tuning in step size increments.

In Test Configuration 1 the smallest entry allowed is .1 MHz and the largest is 1800 MHz. An entry resolution of .1 MHz is allowed only in Test Configuration 1.

In Test Configurations 2 through 6, the smallest entry allowed is 1 MHz and the largest is 1800 MHz. In these test configurations, always enter an integer value of MHz. If a fractional value is entered, the 2075 will automatically round it off to the nearest whole number in MHz, unless Special Function 9.1 is activated. Also, if an entry is made which is too small or too large, the instrument will automatically force that entry to the smallest or largest allowable value, whichever applies.

To enter a Fixed Frequency Step Size (for example, 50 MHz) press:

SHIFT | FIXED FREQ | 50 | ENTER

Note that this procedure is different from the procedure for entering the frequency step size for swept measurements. Also, note that whenever a Swept Frequency Step Size is entered, it replaces the Fixed Frequency Step Size. See items 32 and 40 of Table 3-1, pages 3-11 and 3-14.

Manual Tuning

The frequency to which the 2075 is tuned may be changed by entering a new fixed frequency or by pressing the **UP ARROW** or **DOWN ARROW** keys. These keys move the tuning up or down in increments equal to the Fixed Frequency Step Size.

For example, if the instrument is currently tuned to 1600 MHz and a fixed frequency step size of 50 MHz has been entered, pressing the UP ARROW key once will tune the instrument to 1650 MHz. Pressing the **UP ARROW** key again will tune it to 1700 MHz. Holding the **UP ARROW** or **DOWN ARROW** key will cause continuous incrementing or decrementing. Manual tuning changes the stored value for fixed frequency by setting it equal to the new tuned frequency.

The frequency display will not display fractional frequency values (allowed only in Test Configuration 1) unless Special Function 9.1 is enabled (display 100 KHz resolution).

If the instrument is in the corrected measurement mode (a Second Stage Calibration must already have been performed) when it is tuned to a frequency point for which calibration data has not been taken, error message 110 will appear. The message indicates that measurement is being made at an uncalibrated point. This error can be avoided by pressing the **F** key to place the instrument in the uncorrected (cascade) measurement mode before tuning manually. It can also be avoided by activating Special Function 24.1 which causes calibration data to be interpolated for uncalibrated frequency points.

To perform a second stage calibration in the Fixed Frequency Mode, first tune to the desired frequency and then press:

SHIFT CALIB

The 2075 takes calibration data only for that frequency.

3-7. SWEPT FREQUENCY OPERATION

In Swept Frequency Mode, the 2075 steps from a Start Frequency to a Stop Frequency in discrete increments which are determined by the Swept Frequency Step Size. Measurements are made at the Start Frequency, at each step, and at the Stop Frequency.

In Test Configuration 1 the allowable maximum sweep range is from 10 MHz to 1900 MHz. The minimum step size allowed is .1 MHz.

In Test Configurations 2 through 6, the allowable maximum sweep range is from 10 MHz to 65.535 GHz. The minimum step size allowed is 1 MHz. These limitations are modified, in practice, by the frequency parameters of the external local oscillator, the external mixer, and the noise source in use.

To enter the Start Frequency (for example, 50 MHz) press:

START FREQ 50 ENTER

To enter the Stop Frequency (for example, 1700 MHz) press:

STOP FREQ 1700 ENTER

To enter the Swept Frequency Step Size (for example, 25 MHz) press:

STEP SIZE 25 ENTER

It should be noted that entry of a Swept Frequency Step Size also changes the Fixed Frequency Step Size to the value entered.

Two swept frequency modes are available: Single Sweep and Continuous Automatic Sweeps.

To select Single Sweep Mode and initiate a single swept measurement, press:

SHIFT SWEEP

The 2075 executes a single sweep and then remains tuned to the Stop Frequency.

To select Continuous Automatic Sweeps, press:

SWEEP

The 2075 begins sweeping continuously.

To interrupt a single sweep or continuous sweeps, press:

SWEEP

The instrument stops and remains tuned to the last frequency point measured just before the key was pressed.

To continue the sweep from the point where it was stopped, press:

SHIFT RECALL

Or, to restart the sweep beginning at the Start Frequency, press:

SWEEP or SHIFT SWEEP

If the final increment (Step Size) of a sweep would cause the sweep to go past the programmed Stop Frequency, the instrument tunes only a partial increment and ends that sweep at the Stop Frequency. It should be noted that the partial increment will appear as a full increment if displayed on an oscilloscope.

The Start Frequency, Step Size, and Stop Frequency values also determine the frequency points at which second stage calibration is performed. A maximum of 100 calibration points can be taken. To perform a swept frequency Second Stage Calibration, press:

CALIB

For more information on Second Stage Calibration, see paragraph 3-34, page 3-75.

After power-on, the 2075 is in the Fixed Frequency Mode until a swept mode is selected.

3-8. UNCORRECTED AND CORRECTED MEASUREMENTS

The 2075 allows the user to make any type of measurement and then easily go from one type to another. Figure 3-3 illustrates the relationship between the uncorrected (cascade) and corrected (first stage) measurement modes and shows what measurements can be made in each. The intent here is to show the user:

a. how to switch back and forth from the corrected to the uncorrected mode, and

b. how to make each type of measurement in either mode.

This is not a detailed procedure but is merely intended to give the user an overview of the basic modes and measurement types. Detailed procedures, specific to each test configuration, are given in paragraphs 3-11 through 3-18.

Before any measurements are made, these initial steps must be performed:

1. ENR values (noise source calibration data) must be entered into an ENR table. (Paragraph 3-9)
2. The correct test configuration must be selected. (Paragraph 3-10)
3. All frequency parameters must be entered. After this step the instrument is in the uncorrected (cascade) measurement mode and any uncorrected measurement can now be made. Uncorrected Noise Figure (F) is the default measurement if none is selected.
4. Perform a Second Stage Calibration. After this step the instrument is automatically in the corrected (first stage) measurement mode and any corrected measurement can be made. This step is not required unless corrected measurements are desired. Corrected Noise Figure and Gain (F+G) is the default measurement if none is selected.

The left branch of the diagram shows the choices for uncorrected measurements. The right branch shows the choices for corrected measurements. When in the left branch or the right branch, any of the measurements shown in that branch can be made in any sequence.

Pressing the **F** key changes the mode from the right branch to the left branch (corrected mode to uncorrected mode). Conversely, pressing the **F+G** key changes from the left branch back to the right branch, but only if Second Stage Calibration has been performed. Otherwise perform Step 4 to go from the left branch to the right branch.

Note that no Second Stage Calibration is necessary before making uncorrected measurements. Second Stage Calibration is always necessary before making corrected measurements.

It should be noted that after the keystroke sequence has been entered to choose a particular measurement, it is necessary to select either single sweep (**SHIFT SWEEP**) or continuous automatic sweeps (**SWEEP**) to execute the swept measurement.

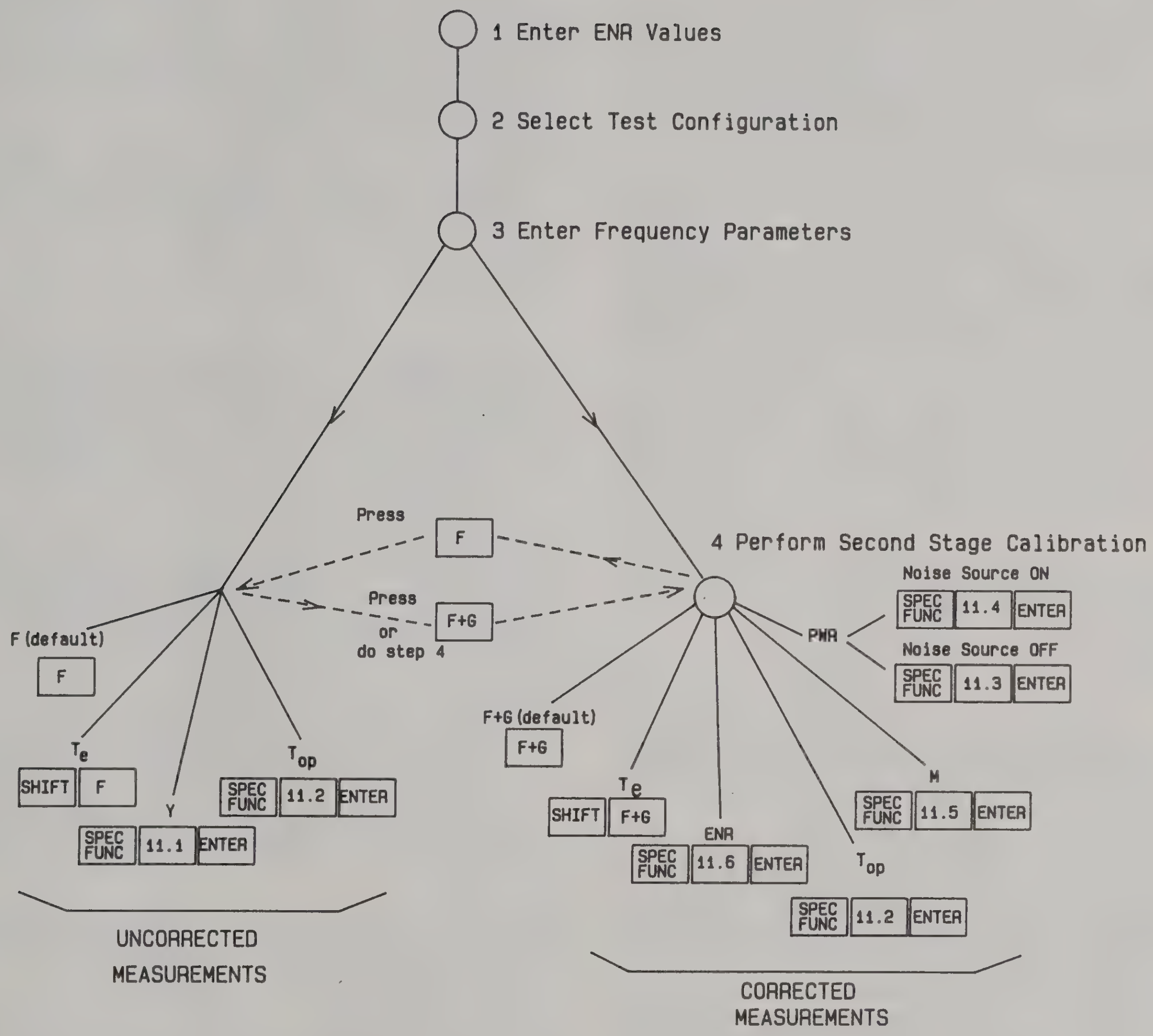


Figure 3-3. UNCORRECTED AND CORRECTED MEASUREMENTS

3-9. ENTRY OF FREQUENCY AND ENR VALUES

After the 2075 has been installed, the first procedure that must be performed prior to operation is the entry of paired frequency and ENR values into the ENR storage table. Tables 1, 2, and 3 each allow entry of up to 31 sets of values. Thus, frequency and ENR values may be stored for as many as 3 separate noise sources. Table 0 can store only one ENR value and uses it for all frequencies. Table 0 generally is used either for fixed frequency measurements, or for swept measurements when the desired accuracy is less than the positive and negative deviations from the nominal ENR value across the frequency range of interest.

Although frequency and ENR values should have been entered into Table 1 during the Second Stage Calibration Procedure (part of the Performance Verification Procedures of Section 5), the procedure below should be performed to insure that the values in the table are those for the noise source which will be used while taking measurements. Measurements cannot be made unless ENR values have been entered.

Perform the following steps:

1. Select the noise source which will be used to make the measurements.
2. Apply AC power to the 2075.
3. Allow several seconds for the 2075 to complete its automatic power-up self-tests. These are completed when the message FCAL has appeared in, and then disappeared from, Window B.
4. Press the **PRESET** key. Wait until the new FCAL message disappears from Window B, signifying that the frequency calibration is completed. PRESET restores the control parameters to a set of known values.
5. Press: `SPEC FUNC` `5.1` `ENTER`

   This calls up, or activates, Table 1. The data about to be entered will be stored in Table 1 (5.2 would have called up Table 2 and 5.3 would have called up Table 3). The error message 104 may appear indicating that no data is currently stored. If so, it may be disregarded.
6. Press: `ENR` `GPIB: EN`

   This places the 2075 in the mode which allows entry of the frequencies and ENR values. The red light in the center of the ENR key is illuminated. Also, the ENTER annunciator in Window A begins to blink, signifying that the operator is required to enter a frequency.
7. Enter the first calibration frequency, in MHz, from the noise source calibration data sheet (for example, 10 MHz) by pressing:

   `10` `ENTER`

   The frequency just entered appears in Window A. The ENTER annunciator in Window B begins to blink signifying that the operator is required to enter the ENR value, in dB, for the frequency just entered.
8. Read the ENR value for the frequency just entered, from the noise source calibration data sheet, or the inscribed label on the calibrated noise source. Enter this value by pressing:

   `numeric keys` `ENTER`

   The value just entered appears in Window B. This completes the entries for the first frequency. The ENTER annunciator in Window A begins to blink, indicating that the next frequency should be entered.
9. Enter the next frequency, in MHz, from the noise source calibration data sheet by pressing:

   `numeric keys` `ENTER`

   The frequency just entered appears in Window A. The ENTER annunciator in Window B begins to blink, signifying that the ENR value for that frequency should now be entered. ENR values are always entered in decibels.

10. Enter the ENR value by pressing:

    numeric keys ENTER

    The value just entered appears in Window B. Now the ENTER annunciator in Window A will start to blink again, indicating that the next frequency should be entered.

11. Continue to enter paired frequency and ENR values for all data points shown on the noise source calibration data sheet. The frequency range of the entries must equal or exceed the range over which measurements will be made. That is, measurements cannot be made at RF frequencies which are outside the lowest and highest frequencies of ENR entries. Up to 31 frequency and ENR value pairs may be entered into each of Tables 1, 2, and 3.

12. After all the entries have been made, use the **DOWN ARROW** and **UP ARROW** keys to examine the entries for correctness. Step down through the table by pressing or holding the **DOWN ARROW** key. Step up through the table by pressing or holding the **UP ARROW** key.

    To clear an erroneous entry, first display it using the **UP** or **DOWN ARROW** keys and then press the **CLEAR** key. Both the frequency and the ENR value will be cleared. Then enter the correct value. The **ENTER** key can be used to toggle the ENTER annunciator back and forth between Window A and Window B. See paragraph 3-31 for more information. To clear the entire table, press:

    SHIFT CLEAR

13. Press: ENR GPIB: EN

    This takes the 2075 out of the ENR table entry and display mode. The red light in the center of the **ENR** key will go out.

14. This completes the entry of ENR data. Because Table 1 was selected (by Special Function 5.1) to store the data, Table 1 will automatically be used by the 2075 when measurements are made. Table 1 will continue to be used until some other table is selected by entering Special Function 5.2, 5.3, 5.4, or 5.0. For more detailed information on use of ENR Tables, see paragraph 3-31.

15. Go to paragraph 3-10 on page 3-27 to select the correct test configuration for the device to be tested.

3-10. SELECTING THE CORRECT TEST CONFIGURATION

The 2075 may be used in any of 6 different test configurations. Generally, the type of Device Under Test and its output frequencies determine which test configuration must be used. Additional considerations are the width of the RF frequency range of the desired measurement, and availability of GPIB compatible local oscillators.

For the purpose of choosing the correct test configuration, consider that there are two basic types of DUT's. These two types may loosely be categorized as amplifier devices or receiver devices. These are defined below:

AMPLIFIER:	Any linear device whose input and output frequencies are the same. This category includes amplifiers, filters, attenuators, isolators, PIN switches, etc.
RECEIVER:	Any linear device (linear in terms of input and output power) whose input and output frequencies are different. This category includes receivers, tuners, mixers, etc.

When the DUT is an amplifier with an output frequency higher than 1850 MHz, external downconversion is required to produce an IF frequency below 1850 MHz. This IF is then input to the 2075. The 2075 has the capability to control the frequency and power of the external local oscillator used in this process (provided that it is GPIB compatible).

The frequency of the local oscillator can be varied by the 2075 to produce a fixed IF (Test Configuration 2). This method is used where the measurement is to be made over a relatively wide RF frequency range. For example, the swept measurement can be made across the RF band from 5 GHz to 10 GHz and converted to a single, fixed frequency IF below 1850 MHz.

The frequency of the local oscillator can remain fixed to produce a variable frequency IF from the mixer (Test Configuration 3). This IF must not vary over a range greater than 1850 MHz or it will exceed the input frequency range of the 2075. This method can be used when the swept measurement is taken across a relatively narrow RF frequency band. In this application the local oscillator need not be GPIB compatible.

Where the DUT is a receiver device such as a mixer, the 2075 can control the frequency and power of the external local oscillator which drives the DUT. Again, the local oscillator frequency can be automatically varied to give a fixed IF output from the DUT, useful for measurement over a wide RF range (Test Configuration 4).

For narrow band measurements, the local oscillator frequency can remain fixed to give a variable IF output (Test Configuration 5).

In cases where the DUT is a receiver having an IF output frequency higher than 1850 MHz, a second stage of external downconversion is required (Test Configuration 6). Here, a fixed frequency local oscillator drives the DUT, giving a variable frequency IF. This variable IF is applied to a second mixer. The local oscillator driving the second mixer is tuned by the 2075 via the IEEE-488 Interface Bus, to give a fixed frequency IF.

Table 3-4 is used to select the correct test configuration for the device to be tested. Read the table from left to right to select the correct test configuration. Then go to the paragraph listed in Column 4 to find the test procedure for that test configuration. Although there are 6 basic test configurations available, 8 possible choices are shown. This is because Configurations 2 and 4 may be used for double sideband or single sideband measurements.

Column 1 shows the two basic types of devices which may be tested. An amplifier device is tested using Configuration 1, 2, or 3. A receiver device is tested using Configuration 4, 5, or 6.

Column 2 shows how the output frequency of the DUT affects the choice of test configuration. For an amplifier device with an output frequency below 1850 MHz, Test Configuration 1 is used. For an amplifier device with an output frequency above 1850 MHz, Test Configuration 2 or 3 is used.

For a receiver device with an IF output frequency below 1850 MHz, Test Configuration 4 or 5 is used. For a receiver device with an IF output frequency above 1850 MHz, Test Configuration 6 is used.

Column 3 shows how the width of the RF measurement range affects the choice of test configuration. Generally, if the measurements are to be taken across an RF range more than 1.6 GHz in width, Configuration 2 or 4 is used because these will support double sideband measurements. A detailed explanation of why single sideband measurements cannot be made over an RF range wider than 1.6 GHz is given in paragraph 3-37.

Column 4 shows which test configuration is required for a device which meets the conditions of Columns 1, 2, and 3, and directs the user to the paragraphs containing that procedure.

Column 5 lists additional information regarding each test configuration.

The selection process as shown in Table 3-4 is not completely inflexible. It is a guide for the new user and will hold true for most applications. The experienced user, however, will find some exceptions. More information is given at the beginning of the procedure for each test configuration.

Figure 3-4 shows, for each test configuration, whether the external local oscillator frequency is fixed or variable, and whether the IF is variable or fixed.

Table 3-4. Selecting the Test Configuration

TYPE OF DEVICE UNDER TEST	OUTPUT FREQUENCY OF DEVICE	WIDTH OF RF MEASUREMENT RANGE PARAGRAPH	TEST CONFIGURATION AND PROCEDURE	COMMENTS
AMPLIFIER	< 1850 MHz	LESS THAN 1840 MHz WIDE	1 (SPEC FUNC 1.1) GO TO PARA. 3-11	No external downconversion is used. Select no sideband.
	> 1850 MHz	MORE THAN 1.6 GHz WIDE	2 (SPEC FUNC 1.2) GO TO PARA. 3-12	Swept LO, Fixed IF. GPIB compatible local oscillator is required. Select Double Sideband.
		LESS THAN 1.6 GHz WIDE	2 (SPEC FUNC 1.2) GO TO PARA. 3-13	Swept LO, Fixed IF. GPIB compatible local oscillator is required. Select Single Sideband.
			3 (SPEC FUND 1.3) GO TO PARA. 3-14	Fixed LO, Swept IF. Local oscillator need not be GPIB compatible. Select Single Sideband.
RECEIVER	< 1850 MHz (IF)	MORE THAN 1.6 GHz WIDE	4 (SPEC FUNC 1.4) GO TO PARA. 3-15	Swept LO, Fixed IF. GPIB compatible local oscillator is required. Select Double Sideband.
		LESS THAN 1.6 GHz WIDE	4 (SPEC FUNC 1.4) GO TO PARA. 3-16	Swept LO, Fixed IF. GPIB compatible local oscillator is required. Select Single Sideband.
			5 (SPEC FUNC 1.5) GO TO PARA. 3-17	Fixed LO, Swept IF. External local oscillator need not be GPIB compatible. Select Single Side-Band.
	> 1850 MHz (IF)		6 (SPEC FUNC 1.6) GO TO PARA. 3-18	The DUT is driven by a fixed frequency local oscillator. The external mixer is driven by a variable frequency local oscillator which must be GPIB compatible. Select Single Sideband.

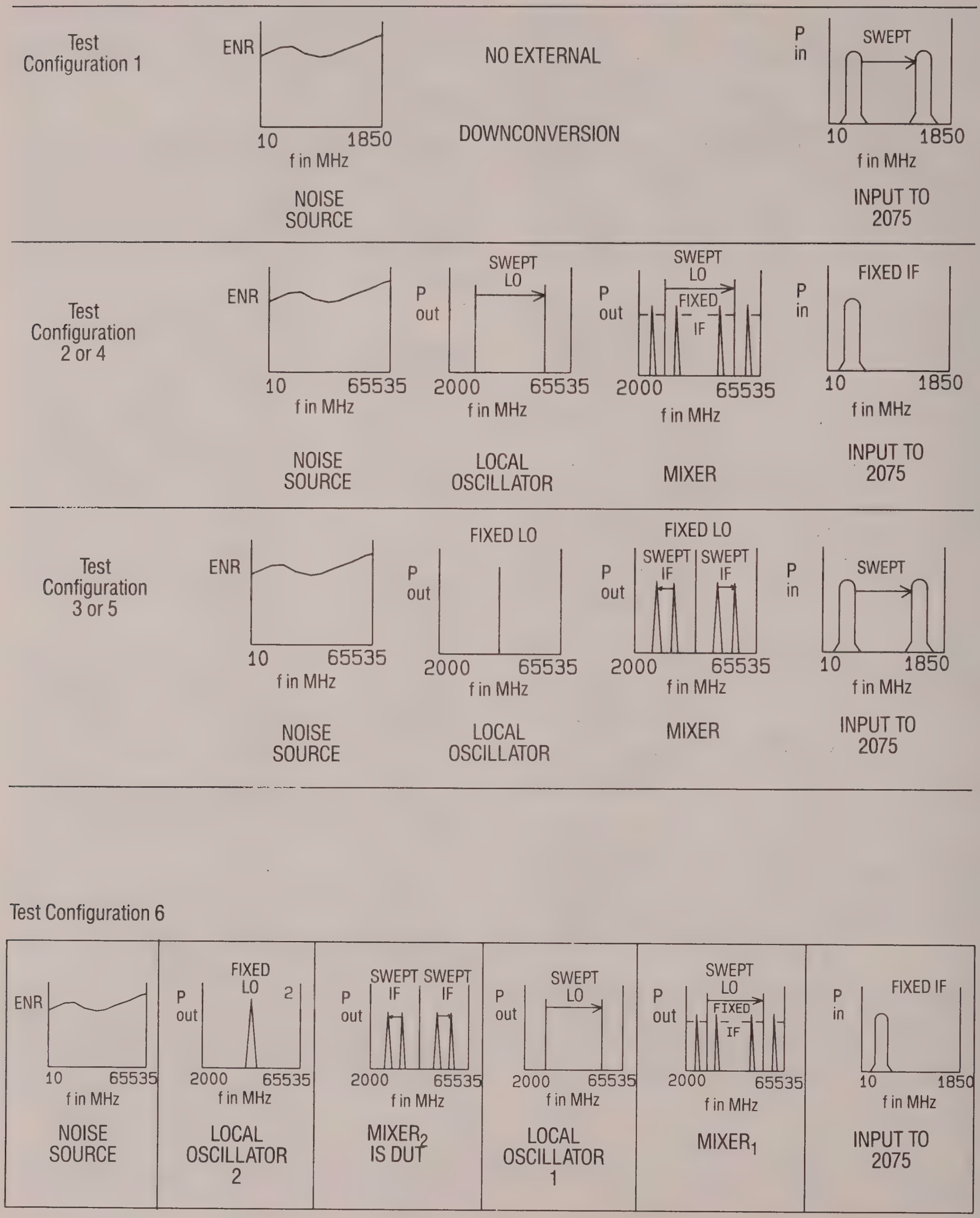


Figure 3-4. TEST CONFIGURATION DOWNCONVERSION MODES

3-11. PROCEDURE FOR TEST CONFIGURATION 1

Description

This configuration is used for measurements when:

1. The DUT is an amplifier-type device.

2. DUT output frequencies are between 10 and 1850 MHz. This is the only test configuration where no external downconversion is used. Note that no sideband parameter (double, single upper, or single lower) selection is required in this test configuration since the 2075 internal conversion system is true single sideband.

Equipment Setup

Figures 3-5a and 3-5b are the connection diagrams for calibration and measurement when external relays are not used. Figure 3-6 shows the optional setup where external relays, controlled by the 2075, are used to provide a calibration path. (Refer to Paragraph 3-34, page 3-75.)

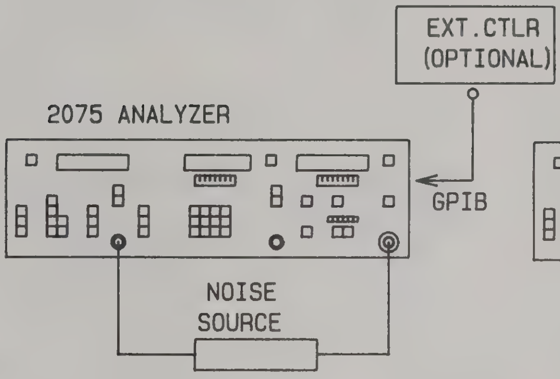


Figure 3-5a. TEST CONFIGURATION 1 Calibration

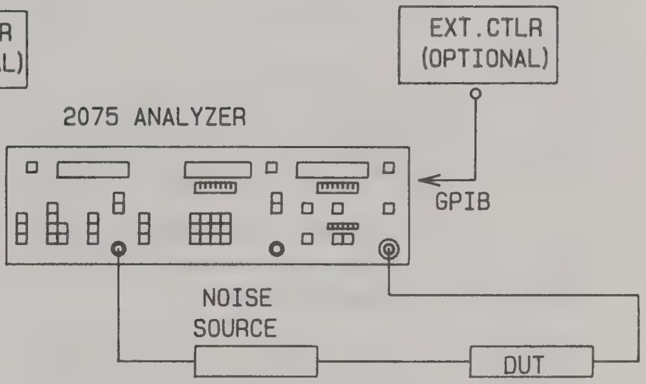


Figure 3-5b. TEST CONFIGURATION 1 Measurement

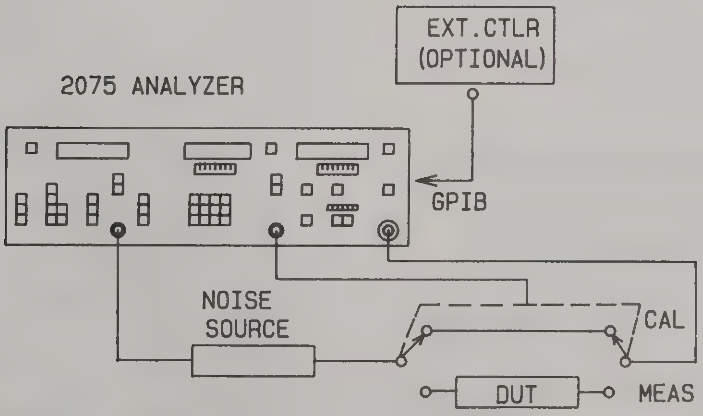


Figure 3-6. EXTERNAL RELAYS AUTOMATE CALIBRATION AND MEASUREMENT PATHS

Procedure

This procedure is used for making corrected Noise Figure and Gain swept measurements. Immediately following the procedure, steps are given for making uncorrected Noise Figure measurements, and Fixed Frequency corrected Noise Figure and Gain measurements. In Paragraphs 3-19 through 3-28, steps are given for making other measurements such as Effective Input Noise Temperature, Y-Factor, etc.

1. Connect the test equipment as shown in the calibration setup of Figure 3-5a or the optional setup of Figure 3-6.

2. Apply AC power to the 2075.

3. Press:

   PRESET

   GPIB: Device Clear or Selective Device Clear

   This sets the front panel control parameters to preset values which also selects Test Configuration 1. (See Paragraph 3-4.)

4. Perform the procedure of Paragraph 3-9 to enter frequency/ENR values unless this has previously been done.

5. Perform the following steps if they apply:

   a. Enter the cold temperature of the noise source. (See Paragraph 3-41, page 3-88.)

   b. Enter any losses before or after the DUT. (See Paragraph 3-40, page 3-86.)

   c. Employ bandwidth compensation if required. (see Paragraph 3-38, page 3-82.)

6. Press:

   SPEC FUNC 14.1 ENTER

   GPIB: T1

   This will activate the HOLD function to prevent the 2075 from making measurements before all the front panel control parameters have been entered.

7. To enter the sweep start frequency (for example, 10 MHz), press:

   START FREQ 10 ENTER

   GPIB: FA10MZ

8. To enter the sweep stop frequency (for example, 1850 MHz), press:

   STOP FREQ 1850 ENTER

   GPIB: FB1850MZ

9. To enter the frequency step size (for example, 20 MHz), press:

   STEP SIZE 20 ENTER

   GPIB: SS20MZ

10. To calibrate the setup, press:
    (For information on smoothing, see Paragraph 3-49 on page 3-110.)

    CALIB

    GPIB: CA

    This initiates the Second Stage Calibration which measures and stores the Noise Figure of the entire setup, including the Noise Figure of the 2075. First a frequency calibration (FCAL) is done and then a CAL0, CAL1, CAL2, and CAL3. The frequency parameters entered in Steps 7, 8, and 9 determine the frequency points for the calibration. In this case the calibration is done every 20 MHz, from 10 to 1850 MHz. Where external relays are used to provide the calibration path, the 2075 automatically applies voltage to the relays when the **CALIB** key is pressed.

11. Deactivate the HOLD function by pressing:

SPEC FUNC | 14.0 | ENTER

GPIB: T0

When the HOLD is deactivated, the 2075 automatically begins making fixed frequency measurements of corrected Noise Figure and Gain at the start frequency, which in this case is 10 MHz. It makes corrected measurements, as opposed to uncorrected measurements, because the Second Stage Calibration has been performed. It makes fixed frequency measurements, as opposed to swept measurements, because the fixed frequency mode is the default mode, and swept mode has not yet been selected.

12. Insert the Device Under Test into the setup, as shown in Figure 3-5b. If external relays are being used, ignore this step. Upon completing the calibration, the 2075 removes the actuating voltage from the relays to place the DUT in the measurement path (unless Special Function 10.1 has been activated).

13. To initiate a single swept measurement, press:

SHIFT | SWEEP

GPIB: SG

As the 2075 steps through the band each RF frequency will be displayed in Window A, each Gain value will be displayed in Window B, and each corrected Noise Figure value will be displayed in Window C. One single sweep is executed and when completed, the 2075 remains tuned to the stop frequency.

14. To initiate continuous swept measurements, press:

SWEEP

GPIB: SR

As the 2075 steps through the band each RF frequency will be displayed in Window A, each Gain value will be displayed in Window B, and each corrected Noise Figure value will be displayed in Window C. The instrument will continue to make automatic continuous sweeps. While the instrument is sweeping, it will not respond to any front panel keys except the **SWEEP** key. Continuous sweeping can be stopped by pressing the **SWEEP** key. A sweep that has been stopped can be continued from the stopping point by pressing **SHIFT RECALL**, or it can be started over from the beginning by pressing **SWEEP.**

Uncorrected Measurement

An uncorrected measurement can be performed by eliminating the Second Stage Calibration or by pressing the **F** key before initiating the sweep.

Fixed Frequency Measurements

To make a fixed frequency (single frequency) measurement instead of swept frequency, insert the following variations into the procedure above. (The example given is for a fixed frequency measurement at 800 MHz.)

a. In place of Step 7, press:

FIXED FREQ | 800 | ENTER

b. Do not perform Steps 8 and 9.

c. In place of Step 10, Calibration, press:

SHIFT | CALIB

This initiates a calibration at the fixed frequency.

3-12. PROCEDURE FOR TEST CONFIGURATION 2 (FOR DOUBLE SIDEBAND MEASUREMENTS)

Description

This configuration is used for measurements when:

1. The DUT is an amplifier-type device.

2. The DUT output frequencies are higher than 1850 MHz.

3. The RF range over which measurements will be taken is more than 1.6 GHz wide. (Measurements must be made using double sideband mode.)

4. The RF range over which measurements will be taken can be less than 1.6 GHz wide. However, the fixed IF must be low enough in frequency so that the two sidebands are close together and will approximate a single sideband measurement.

In this configuration external downconversion is required. The 2075 or an external controller sweeps the variable local oscillator frequency to produce a fixed frequency IF from the external mixer. The local oscillator must be GPIB compatible. Paragraph 3-44 on page 3-95 contains information on PROM stored control programs for external local oscillators. Paragraph 3-45 on page 3-96 contains information on writing user-defined control programs for external local oscillators.

Equipment Setup

Figures 3-7a and 3-7b are the connection diagrams for calibration and measurement when external relays are not used. An optional setup can be used where external relays, controlled by the 2075, are used to provide a calibration path. (Refer to Paragraph 3-34, page 3-75.)

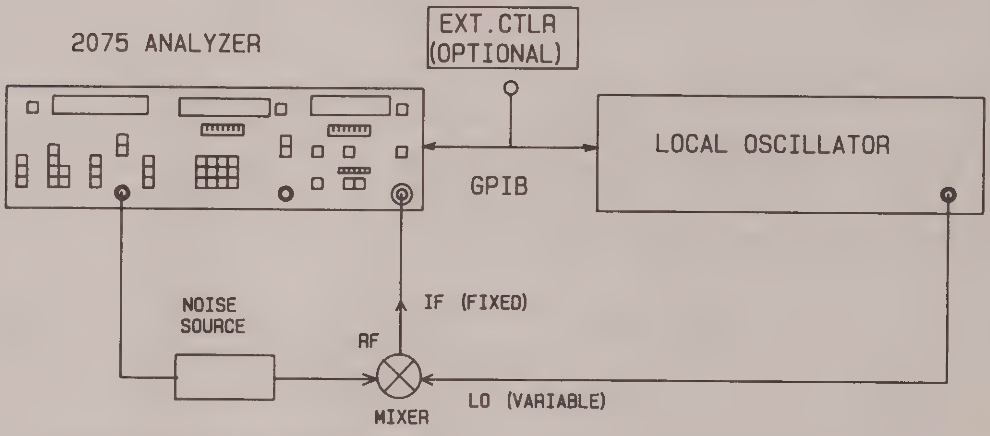


Figure 3-7a. TEST CONFIGURATION 2 CALIBRATION (DOUBLE SIDEBAND)

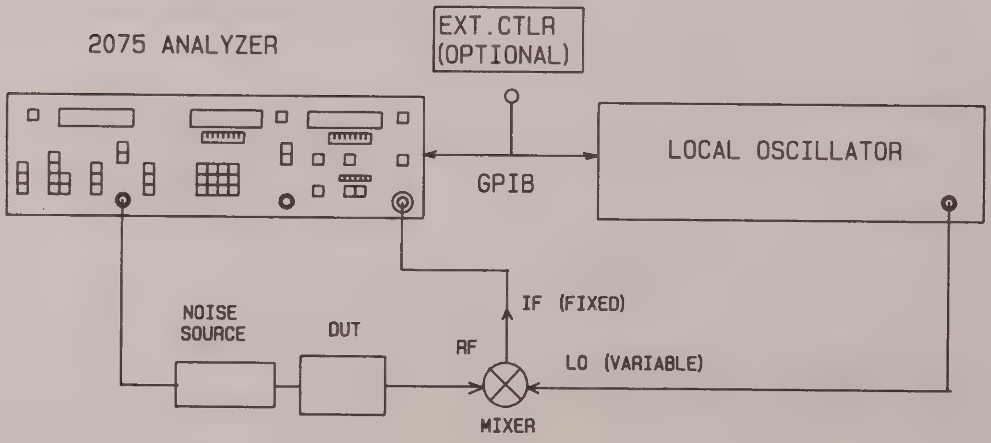


Figure 3-7b. TEST CONFIGURATION 2 MEASUREMENT (DOUBLE SIDEBAND)

Procedure

This procedure is used for making corrected Noise Figure and Gain swept measurements. Immediately following the procedure, steps are given for making fixed frequency corrected Noise Figure and Gain measurements. In Paragraphs 3-19 through 3-28, steps are given for making other measurements such as Effective Input Noise Temperature, Y-Factor, etc.

1. Connect the test equipment as shown in the calibration setup of Figure 3-7a or the optional setup using external relays.
2. Apply AC power to the 2075.
3. Press:

   PRESET

   GPIB: Device Clear or Selective Device Clear

   This sets the front panel control parameters to preset values. (See Paragraph 3-4.)
4. Perform the procedure of Paragraph 3-9 to enter Frequency/ENR values, unless this has previously been done.
5. Press:

   SPEC FUNC | 1.2 | ENTER

   GPIB: D2

   This selects Test Configuration 2.
6. Perform the following steps if they apply:
   - a. Enter the cold temperature of the noise source. (See Paragraph 3-41, page 3-88.)
   - b. Enter any losses before or after the DUT. (See Paragraph 3-40, page 3-86.)
   - c. Employ bandwidth compensation if required. (See Paragraph 3-38, page 3-82.)
7. Press:

   SPEC FUNC | 14.1 | ENTER

   GPIB: T1

   This will activate the HOLD function which prevents the 2075 from making measurements before all the front panel control parameters have been entered.
8. To enter the sweep start RF frequency (for example, 8000 MHz), press:

   START FREQ | 8000 | ENTER

   GPIB: FA8000MZ
9. To enter the sweep stop RF frequency (for example, 12000 MHz), press:

   STOP FREQ | 12000 | ENTER

   GPIB: FB12000MZ
10. To enter the frequency step size (for example, 200 MHz), press:

    STEP SIZE | 200 | ENTER

    GPIB: SS200MZ
11. To enter the fixed IF frequency (for example, 15 MHz), press:

    SHIFT | START FREQ | 15 | ENTER

    GPIB: IF15MZ

12. To select double sideband, press:

SPEC FUNC | 2.0 | ENTER

GPIB: A0

13. To select the correct program for controlling the external local oscillator (for example, an HP 8672A local oscillator), press:

SPEC FUNC | 47.0 | ENTER

Refer to Paragraphs 3-44 and 3-45 for more information on control programs.

14. To set the local oscillator power level (Always entered in dBm. In this example it is 6 dBm.), press:

SHIFT | ⇧ | 6 | ENTER

15. To enter the local oscillator settling time, which will allow the local oscillator to stabilize at each frequency before the measurement is made (Always entered in milliseconds. In this example it is 20 ms.), press:

SPEC FUNC | 3.1 | ENTER

20 | ENTER

16. To enter the GPIB address for the external local oscillator (In this example it is 17.), press:

SHIFT | LOCAL | 17 | ENTER

17. To make the 2075 the controller and enable the program which will control the local oscillator, press:

SPEC FUNC | 40.2 | ENTER

18. To calibrate the setup, press:
(For information on smoothing, see Paragraph 3-49 on page 3-110.)

CALIB

GPIB: CA

This initiates the Second Stage Calibration which measures and stores the Noise Figure of the entire setup, including the internal Noise Figure of the 2075. First a frequency calibration (FCAL) is done and then a CAL0, CAL1, CAL2, and CAL3. The frequency parameters entered in Steps 8, 9, and 10 determine the frequency points for the calibration. In this case the calibration is done every 200 MHz, from 8000 MHz to 12000 MHz. When external relays are used to provide the calibration path, the 2075 automatically applies voltage to the relays when the **CALIB** key is pressed.

19. Deactivate the HOLD function by pressing:

SPEC FUNC | 14.0 | ENTER

GPIB: T0

When the HOLD is deactivated, the 2075 automatically begins making fixed frequency measurements of corrected Noise Figure and Gain at the start frequency, which in this case is 8000 MHz. It makes corrected measurements, as opposed to uncorrected measurements, because the Second Stage Calibration has been performed. It makes fixed frequency measurements, as opposed to swept measurements, because the fixed frequency mode is the default mode, and swept mode has not yet been selected.

20. Insert the Device Under Test into the setup, as shown in Figure 3-7b. If external relays are being used, ignore this step. Upon completing the calibration, the 2075 removes the actuating voltage from the relays to place the DUT in the measurement path (unless Special Function 10.1 has been activated).

21. To initiate a single swept measurement, press:

    SHIFT SWEEP GPIB: SG

    As the 2075 steps through the band each RF frequency will be displayed in Window A, each corrected Gain value will be displayed in Window B, and each corrected Noise Figure value will be displayed in Window C. One single sweep is executed and when completed, the 2075 remains tuned to the stop frequency.

22. To initiate continuous swept measurements, press:

    SWEEP GPIB: SR

    As the 2075 steps through the band each RF frequency will be displayed in Window A, each corrected Gain value will be displayed in Window B, and each corrected Noise Figure value will be displayed in Window C. The instrument will continue to make automatic continuous sweeps. While the instrument is sweeping, it will not respond to any front panel keys except the **SWEEP** key. Continuous sweeping can be stopped by pressing the **SWEEP** key. A sweep that has been stopped can be continued from the stopping point by pressing **SHIFT RECALL** or it can be started over from the beginning by pressing **SWEEP**.

Uncorrected Measurement

An uncorrected measurement can be performed by eliminating the Second Stage Calibration or by pressing the **F** key before initiating the sweep.

Fixed Frequency Measurements

To make a fixed frequency (single frequency) measurement instead of swept frequency, insert the following variations into the procedure above. (The example given is for a fixed frequency measurement at 9000 MHz.)

a. In place of Step 8, press:

   FIXED FREQ 9000 ENTER

b. Do not perform Steps 9 and 10.

c. In place of Step 18, Calibration, press:

   SHIFT CALIB

   This initiates a calibration at the fixed frequency.

3-13. PROCEDURE FOR TEST CONFIGURATION 2 (FOR SINGLE SIDEBAND MEASUREMENTS)

Description

This configuration is used for measurements when:

1. The DUT is an amplifier-type device.
2. The DUT output frequencies are higher than 1850 MHz.
3. The RF range over which measurements will be taken is less than 1.6 GHz wide. (Measurements are made using single sideband mode only.)
4. The DUT has sharp variations in noise figure across the RF band, such that even a double sideband measurement with a 10 MHz IF is too coarse to resolve the variations.

In this configuration external downconversion is required. The 2075 or an external controller sweeps the variable local oscillator frequency to produce a fixed frequency IF from the external mixer.

The local oscillator must be GPIB compatible. Paragraph 3-44, page 3-95, contains information on PROM stored control programs for external local oscillators. Paragraph 3-45, page 3-96, contains information on writing user defined control programs for external local oscillators.

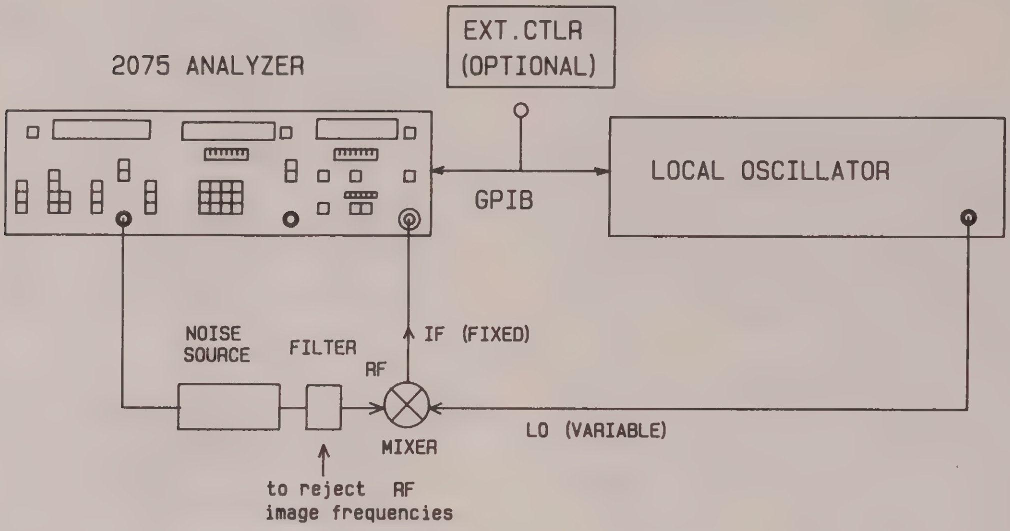


Figure 3-8a. TEST CONFIGURATION 2 CALIBRATION (SINGLE SIDEBAND)

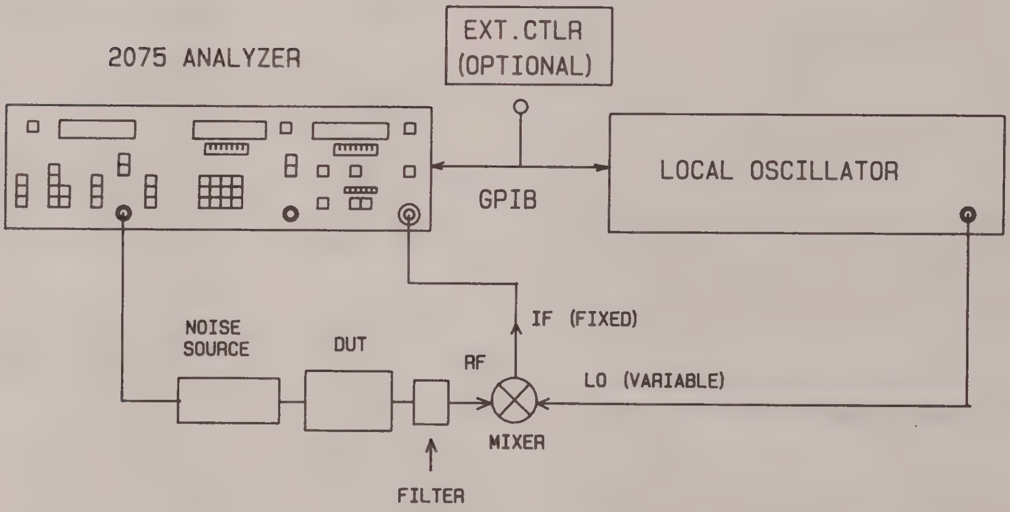


Figure 3-8b. TEST CONFIGURATION 2 MEASUREMENT (SINGLE SIDEBAND)

Equipment Setup

Figures 3-8a and 3-8b are the connection diagrams for calibration and measurement when external relays are not used. An optional setup can be used where external relays, controlled by the 2075, provide a calibration path. (See Paragraph 3-34, page 3-75.)

Procedure

This procedure is used for making corrected Noise Figure and Gain swept measurements. Immediately following the procedure, steps are given for making fixed frequency corrected Noise Figure and Gain measurements. In Paragraphs 3-19 through 3-28, steps are given for making other measurements such as Effective Input Noise Temperature, Y-Factor, etc.

1. Connect the test equipment as shown in the calibration setup of Figure 3-8a or the optional setup using external relays.

2. Apply AC power to the 2075.

3. Press:

PRESET

GPIB: Device Clear or Selective Device Clear

This sets the front panel control parameters to preset values. (See Paragraph 3-4.)

4. Perform the procedure of Paragraph 3-9 to enter Frequency/ENR values unless this has previously been done.

5. Press:

SPEC FUNC
1.2
ENTER

GPIB: D2

This selects Test Configuration 2.

6. Perform the following steps if they apply:

    a. Enter the cold temperature of the noise source. (See Paragraph 3-41, page 3-88.)

    b. Enter any losses before or after the DUT. (See Paragraph 3-40, page 3-86.)

    c. Employ bandwidth compensation if required. (See Paragraph 3-38, page 3-82.)

7. Press:

SPEC FUNC
14.1
ENTER

GPIB: T1

This will activate the HOLD function and prevent the 2075 from making measurements before all the front panel control parameters have been entered.

8. To enter the sweep start RF frequency (for example, 8000 MHz), press:

START FREQ
8000
ENTER

GPIB: FA8000MZ

9. To enter the sweep stop RF frequency (for example, 9200 MHz), press:

STOP FREQ
9200
ENTER

GPIB: FB9200MZ

10. To enter the frequency step size (for example, 25 MHz), press:

STEP SIZE
25
ENTER

GPIB: SS25MZ

11. To enter the fixed IF frequency (for example, 1500 MHz), press:

SHIFT
START FREQ
1500
ENTER

GPIB: IF1500MZ

12. To select the desired single sideband parameter (In this example, lower sideband), press:

SPEC FUNC
2.1
ENTER

GPIB: A1

Upper sideband would be:

SPEC FUNC 2.2 ENTER

GPIB: A2

13. To select the correct program for controlling the external local oscillator (for example, an HP8672A local oscillator), press:

SPEC FUNC 47.0 ENTER

(Refer to Paragraphs 3-44 and 3-45 for more information on this feature.)

14. To set the local oscillator power level (Always entered in dBm. In this example it is 6 dBm.), press:

SHIFT ⇧ 6 ENTER

15. To enter the local oscillator settling time, which will allow the local oscillator frequency to stabilize before each measurement (Always entered in milliseconds. In this example it is 20 ms.), press:

SPEC FUNC 3.1 ENTER

20 ENTER

16. To enter the GPIB address for the external local oscillator (In this example it is 17.), press:

SHIFT LOCAL 17 ENTER

17. To make the 2075 the controller and to enable the program which will control the local oscillator, press:

SPEC FUNC 40.2 ENTER

18. To calibrate the setup, press:
(For information on smoothing, see Paragraph 3-49 on page 3-110.)

CALIB

GPIB: CA

This initiates the Second Stage Calibration which measures and stores the Noise Figure of the entire setup, including the Noise Figure of the 2075. First a frequency calibration (FCAL) is done and then a CAL0, CAL1, CAL2, and CAL3. The frequency parameters entered in Steps 8, 9, and 10 determine the frequency points for the calibration. In this case the calibration is done every 25 MHz, from 8000 to 9200 MHz. When external relays are used to provide the calibration path, the 2075 automatically applies voltage to the relays when the **CALIB** key is pressed.

19. Deactivate the HOLD function by pressing:

SPEC FUNC 14.0 ENTER

GPIB: T0

When the HOLD is deactivated, the 2075 automatically begins making fixed frequency measurements of corrected Noise Figure and Gain at the start frequency, which in this case is 8000 MHz. It makes corrected measurements, as opposed to uncorrected measurements, because the Second Stage Calibration has been performed. It makes fixed frequency measurements, as opposed to swept measurements, because the fixed frequency mode is the default mode, and swept mode has not yet been selected.

20. Insert the Device Under Test into the setup, as shown in Figure 3-8b. If external relays are being used, ignore this step. Upon completing the calibration, the 2075 removes the actuating voltage from the relays to place the DUT in the measurement path (unless Special Function 10.1 has been activated).

21. To initiate a single swept measurement, press:

SHIFT SWEEP

GPIB: SG

As the 2075 steps through the band each RF frequency will be displayed in Window A, each corrected Gain value will be displayed in Window B, and each corrected Noise Figure value will be displayed in Window C. One single sweep is executed and when completed, the 2075 remains tuned to the stop frequency.

22. To initiate continuous swept measurements, press:

SWEEP

GPIB: SR

As the 2075 steps through the band each RF frequency will be displayed in Window A, each corrected Gain value will be displayed in Window B, and each corrected Noise Figure value will be displayed in Window C. The instrument will continue to make automatic continuous sweeps. While the instrument is sweeping, it will not respond to any front panel keys except the **SWEEP** key. Continuous sweeping can be stopped by pressing the **SWEEP** key. A sweep that has been stopped can be continued from the stopping point by pressing **SHIFT RECALL** or it can be started over from the beginning by pressing **SWEEP**.

Uncorrected Measurement

An uncorrected measurement can be performed by eliminating the Second Stage Calibration or by pressing the **F** key before initiating the sweep.

Fixed Frequency Measurements

To make a fixed frequency (single frequency) measurement instead of swept frequency, insert the following variations into the procedure above. (The example given is for a fixed frequency measurement at 8500 MHz.)

a. In place of Step 8, press:

FIXED FREQ 8500 ENTER

b. Do not perform Steps 9 and 10.

c. In place of Step 18, Calibration, press:

SHIFT CALIB

This initiates a calibration at the fixed frequency.

3-14. PROCEDURE FOR TEST CONFIGURATION 3 (USING SINGLE SIDEBAND)

Description

This configuration is used for measurements when:

1. The DUT is an amplifier-type device.
2. The DUT output frequencies are higher than 1850 MHz.
3. The RF range over which measurements will be taken is less than 1.6 GHz wide. (Measurements are made using single sideband mode only.)
4. The DUT has sharp variations in noise figure across the RF band, such that even a double sideband measurement with a 10 MHz IF is too coarse to resolve the variations.
5. A GPIB compatible local oscillator is not available.

In this configuration external downconversion is required. The local oscillator frequency is fixed and need not be controlled by the 2075 or by an external controller. However, if a GPIB compatible local oscillator is available, its fixed frequency and its power level can be controlled by the 2075 or an external controller. In either case, the IF output from the Device Under Test varies and must not exceed 1850 MHz.

Paragraph 3-44, page 3-95, contains information on PROM stored control programs for external local oscillators. Paragraph 3-45, page 3-96, contains information on writing user defined control programs for external local oscillators.

Equipment Setup

Figures 3-9a and 3-9b are the connection diagrams for calibration and measurement when external relays are not used. An optional setup can be used where external relays, controlled by the 2075, provide the calibration path. (See Paragraph 3-34, page 3-75.)

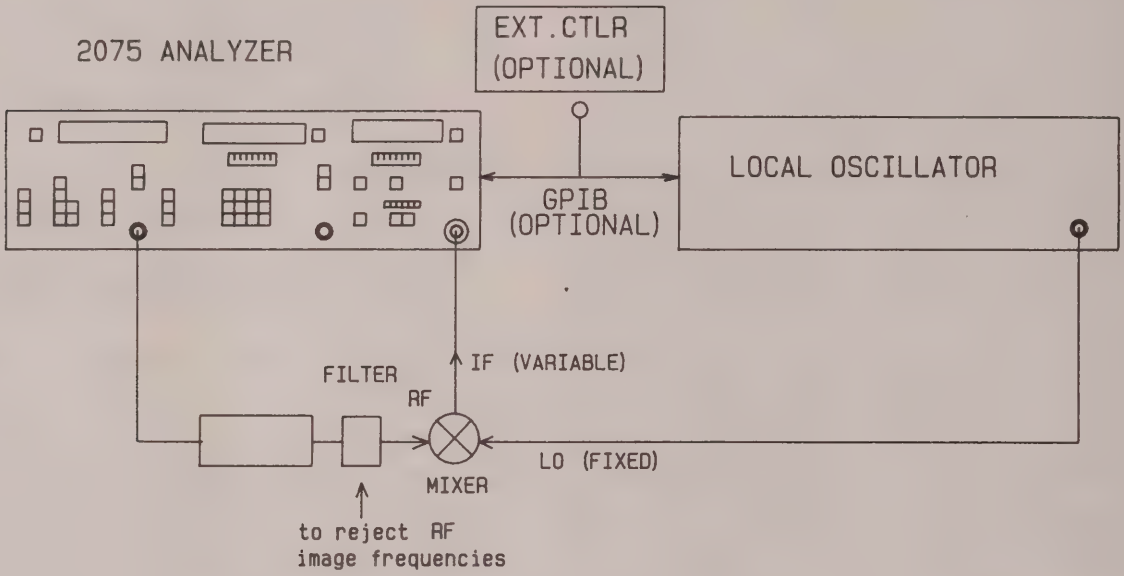


Figure 3-9a. TEST CONFIGURATION 3 CALIBRATION

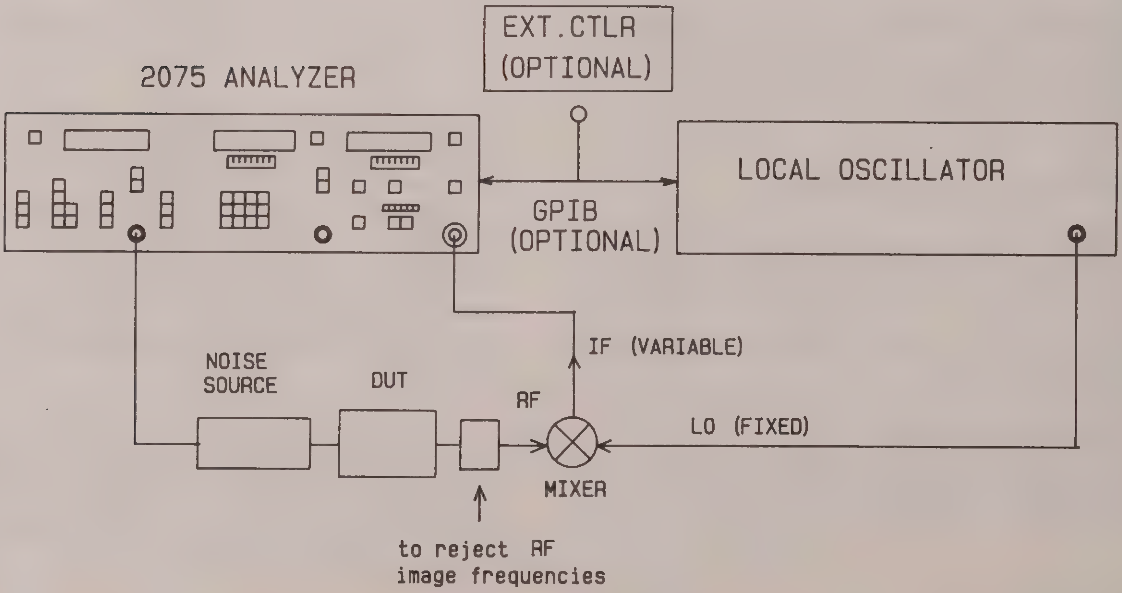


Figure 3-9b. TEST CONFIGURATION 3 MEASUREMENT

Procedure

This procedure is used for making corrected Noise Figure and Gain swept measurements. Immediately following the procedure, steps are given for making fixed frequency corrected Noise Figure and Gain measurements. In Paragraphs 3-19 through 3-28, steps are given for making other measurements such as Effective Input Noise Temperature, Y-Factor, etc.

1. Connect the test equipment as shown in the calibration setup of Figure 3-9a or the optional setup using external relays for calibration.

2. Apply AC power to the 2075.

3. Press:

   PRESET

   GPIB: Device Clear or Selective Device Clear

   This sets the front panel control parameters to preset values. (See Paragraph 3-4.)

4. Perform the procedure of Paragraph 3-9 to enter Frequency/ENR values unless this has previously been done.

5. Press:

   SPEC FUNC 1.3 ENTER

   GPIB: D3

   This selects Test Configuration 3.

6. Perform the following steps if they apply:

   a. Enter the cold temperature of the noise source. (See Paragraph 3-41, page 3-88.)

   b. Enter any losses before or after the DUT. (See Paragraph 3-40, page 3-86.)

   c. Employ bandwidth compensation if required. (See Paragraph 3-38, page 3-82.)

7. Press:

   SPEC FUNC 14.1 ENTER

   GPIB: T1

   This will activate the HOLD function. This prevents the 2075 from making measurements before all the front panel control parameters have been entered.

8. To enter the sweep start RF frequency (for example, 5900 MHz), press:

   START FREQ 5900 ENTER

   GPIB: FA5900MZ

9. To enter the sweep stop RF frequency (for example, 6500 MHz), press:

   STOP FREQ 6500 ENTER

   GPIB: FB6500MZ

10. To enter the frequency step size (for example, 20 MHz), press:

    STEP SIZE 20 ENTER

    GPIB: SS20MZ

11. To enter the fixed local oscillator frequency (for example, 7700 MHz), press:

    SHIFT STOP FREQ 7700 ENTER

    GPIB: LO7700MZ

12. To select the desired single sideband parameter (in this example, lower sideband), press:

SPEC FUNC   2.1   ENTER

GPIB: A1

Upper sideband would be:

SPEC FUNC   2.2   ENTER

GPIB: A2

Perform Steps 13 through 16 only if the external local oscillator is under GPIB control. Otherwise, go to Step 17.

13. To select the correct program for controlling the external local oscillator (for example, an HP8672A local oscillator), press:

SPEC FUNC   47.0   ENTER

14. To set the local oscillator power level (Always entered in dBm. In this example it is 6 dBm.), press:

SHIFT   ⇧   6   ENTER

15. To enter the GPIB address for the external local oscillator (In this example it is 17.), press:

SHIFT   LOCAL   17   ENTER

16. To make the 2075 the controller and enable the program which will control the local oscillator, press:

SPEC FUNC   40.2   ENTER

17. To calibrate the setup, press:
(For information on smoothing, see Paragraph 3-49 on page 3-110.)

CALIB

GPIB: CA

This initiates the Second Stage Calibration which measures and stores the Noise Figure of the entire setup, including the Noise Figure of the 2075. First a Frequency Calibration (FCAL) is done and then a CAL0, CAL1, CAL2, and CAL3. The frequency parameters entered in Steps 8, 9, and 10 determine the frequency points for the calibration. In this case the calibration is done every 20 MHz, from 5900 to 6500 MHz. When external relays are used to provide the calibration path, the 2075 automatically applies voltage to the relays when the **CALIB** key is pressed.

18. Deactivate the HOLD function by pressing:

SPEC FUNC   14.0   ENTER

GPIB: T0

When the HOLD is deactivated, the 2075 automatically begins making fixed frequency measurements of corrected Noise Figure and Gain at the start frequency, which in this case is 5900 MHz. It makes corrected measurements, as opposed to uncorrected measurements, because the Second Stage Calibration has been performed. It makes fixed frequency measurements, as opposed to swept measurements, because the fixed frequency mode is the default mode, and swept mode has not yet been selected.

19. Insert the Device Under Test into the setup, as shown in Figure 3-9b. If external relays are being used, ignore this step. Upon completing the calibration, the 2075 removes the actuating voltage from the relays to place the DUT in the measurement path (unless Special Function 10.1 has been activated).

20. To initiate a single swept measurement, press:

SHIFT   SWEEP

GPIB: SG

As the 2075 steps from the IF's of 1800 to 1200 MHz in steps of 20 MHz, it will display the actual RF frequencies from 5900 MHz to 6500 MHz in Window A. Each corrected Gain value will be displayed in Window B, and each corrected Noise Figure value will be displayed in Window C. One single sweep is executed and when completed, the 2075 remains tuned to the stop frequency.

21. To initiate continuous swept measurements, press:

SWEEP

GPIB: SR

As the 2075 steps from the IF's of 1800 to 1200 MHz in steps of 20 MHz, it will display the actual RF frequencies from 5900 MHz to 6500 MHz in Window A. Each corrected Gain value will be displayed in Window B, and each corrected Noise Figure value will be displayed in Window C. The instrument will continue to make automatic continuous sweeps. While the instrument is sweeping, it will not respond to any front panel keys except the **SWEEP** key. Continuous sweeping can be stopped by pressing the **SWEEP** key. A sweep that has been stopped can be continued from the stopping point by pressing **SHIFT RECALL** or it can be started over from the beginning by pressing **SWEEP**.

Uncorrected Measurement

An uncorrected measurement can be performed by eliminating the Second Stage Calibration or by pressing the **F** key before initiating the sweep.

Fixed Frequency Measurements

To make a fixed frequency (single frequency) measurement instead of swept frequency, insert the following variations into the procedure above. (The example given is for a fixed frequency measurement at 5900 MHz.)

a. In place of Step 8, press:

FIXED FREQ   5900   ENTER

b. Do not perform Steps 9 and 10.

c. In place of Step 17, Calibration, press:

SHIFT   CALIB

This initiates a calibration at the fixed frequency.

3-15. PROCEDURE FOR TEST CONFIGURATION 4 (FOR DOUBLE SIDEBAND MEASUREMENTS)

Description

This configuration is used for measurements when:

1. The DUT is a receiver-type device.
2. The DUT output frequencies (IF) are lower than 1850 MHz.
3. The RF range over which measurements will be taken is more than 1.6 GHz wide. (Measurements must be made using double sideband mode.)
4. The RF range over which measurements will be taken can be less than 1.6 GHz wide. However, the fixed IF must be low enough in frequency so that the two sidebands are close together and will approximate a single sideband measurement.

In this configuration external downconversion is performed in the DUT. The 2075 or an external controller sweeps the variable local oscillator frequency to produce a fixed frequency IF from the Device Under Test. The local oscillator must be GPIB compatible.

Paragraph 3-44, page 3-95, contains information on PROM stored control programs for external local oscillators. Paragraph 3-45, page 3-96, contains information on writing user defined control programs for external local oscillators.

Equipment Setup

Figures 3-10a and 3-10b are the connection diagrams for calibration and measurement when external relays are not used. An optional setup can be used where external relays, controlled by the 2075, provide a calibration path. (See Paragraph 3-34, page 3-75.)

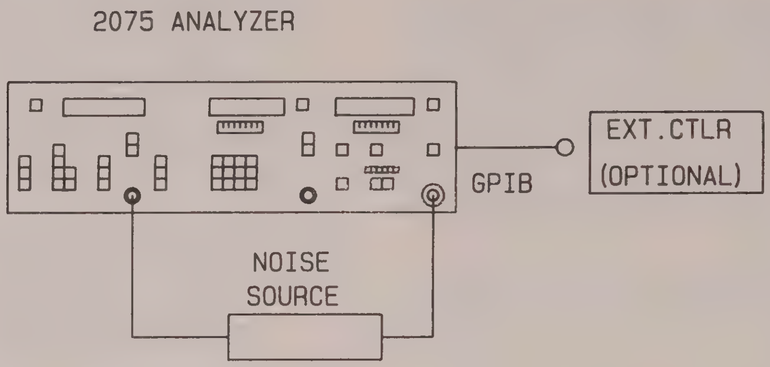


Figure 3-10a. TEST CONFIGURATION 4 CALIBRATION (DOUBLE SIDEBAND)

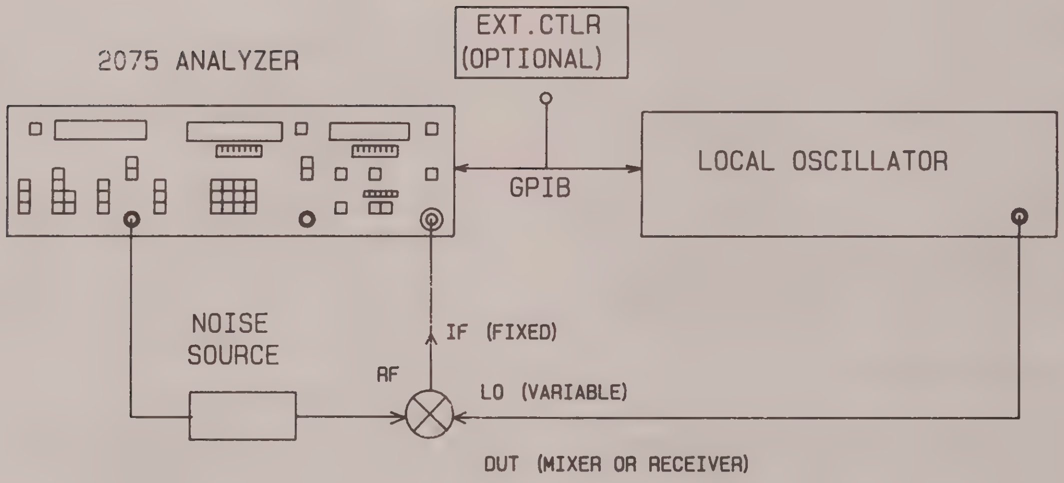


Figure 3-10b. TEST CONFIGURATION 4 MEASUREMENT (DOUBLE SIDEBAND)

Procedure

This procedure is used for making corrected Noise Figure and Gain swept measurements. Immediately following the procedure, steps are given for making fixed frequency corrected Noise Figure and Gain measurements. In Paragraphs 3-19 through 3-28, steps are given for making other measurements such as Effective Input Noise Temperature, Y-Factor, etc.

1. Connect the test equipment as shown in the calibration setup of Figure 3-10a or the optional setup where external relays are used to provide the calibration path.

2. Apply AC power to the 2075.

3. Press:

   PRESET

   GPIB: Device Clear or Selective Device Clear

   This sets the front panel control parameters to preset values. (See Paragraph 3-4.)

4. Perform the procedure of Paragraph 3-9 to enter Frequency/ENR values unless this has previously been done.

5. Press:

   SPEC FUNC 1.4 ENTER

   GPIB: D4

   This selects Test Configuration 4.

6. Perform the following steps if they apply:

   a. Enter the cold temperature of the noise source. (See Paragraph 3-41, page 3-88.)

   b. Enter any losses before or after the DUT. (See Paragraph 3-40, page 3-86.)

   c. Employ bandwidth compensation if required. (See Paragraph 3-38, page 3-82.)

7. Press:

   SPEC FUNC 14.1 ENTER

   GPIB: T1

   This will activate the HOLD function. This prevents the 2075 from making measurements before all the front panel control parameters have been entered.

8. To enter the sweep start RF frequency (for example, 6000 MHz), press:

   START FREQ 6000 ENTER

   GPIB: FA6000MZ

9. To enter the sweep stop RF frequency (for example, 18000 MHz), press:

   STOP FREQ 18000 ENTER

   GPIB: FB18000MZ

10. To enter the frequency step size (for example, 200 MHz), press:

    STEP SIZE 200 ENTER

    GPIB: SS200MZ

11. To enter the fixed IF frequency (for example, 10 MHz), press:

    SHIFT START FREQ 10 ENTER

    GPIB: IF10MZ

12. To select double sideband, press:

    SPEC FUNC 2.0 ENTER

    GPIB: A0

13. To select the correct program for controlling the external local oscillator (for example, an HP8672A local oscillator), press:

    SPEC FUNC   47.0   ENTER

    See Paragraphs 3-44 and 3-45 for information on control programs for external local oscillators.

14. To set the local oscillator power level (Always entered in dBm. In this example it is 6 dBm.), press:

    SHIFT   ⇧   6   ENTER

15. To enter the local oscillator settling time, which allows the local oscillator to stabilize each frequency (Always entered in milliseconds. In this example it is 20 ms.), press:

    SPEC FUNC   3.1   ENTER

    20   ENTER

16. To enter the GPIB address of the external local oscillator (in this example the address is 17), press:

    SHIFT   LOCAL   17   ENTER

17. To make the 2075 the controller and enable the program which will control the local oscillator, press:

    SPEC FUNC   40.2   ENTER

18. To calibrate the setup, press:
    (For information on smoothing, see Paragraph 3-49 on page 3-110.)

    CALIB

    GPIB: CA

    This initiates the Second Stage Calibration which measures and stores the Noise Figure of the entire setup, including the Noise Figure of the 2075. First a frequency calibration (FCAL) is done and then a CAL0, CAL1, CAL2, and CAL3. The frequency parameters entered in Steps 8, 9, and 10 determine the frequency points for the calibration. In this case the calibration is done at the fixed IF frequency of 10 MHz. When external relays are used to provide the calibration path, the 2075 automatically applies voltage to the relays when the **CALIB** key is pressed.

19. Deactivate the HOLD function by pressing:

    SPEC FUNC   14.0   ENTER

    GPIB: T0

    When the HOLD is deactivated, the 2075 automatically begins making fixed frequency measurements of corrected Noise Figure and Gain at the start frequency, which in this case is 6000 MHz. It makes corrected measurements, as opposed to uncorrected measurements, because the Second Stage Calibration has been performed. It makes fixed frequency measurements, as opposed to swept measurements, because the fixed frequency mode is the default mode, and swept mode has not yet been selected.

20. Insert the Device Under Test into the setup, as shown in Figure 3-10b. If external relays are being used, ignore this step. Upon completing the calibration, the 2075 removed the actuating voltage from the external relays to place the DUT in the measurement path (unless Special Function 10.1 has been activated).

21. To initiate a single swept measurement, press:

    SHIFT   SWEEP

    GPIB: SG

    As the 2075 steps through the band each RF frequency will be displayed in Window A, each corrected Gain value will be displayed in Window B, and each corrected Noise Figure value will be displayed in Window C. One single sweep is executed and, when completed, the 2075 remains tuned to the stop frequency.

22. To initiate continuous swept measurements, press:

SWEEP GPIB: SR

As the 2075 steps through the band each frequency will be displayed in Window A, each corrected Gain value will be displayed in Window B, and each corrected Noise Figure value will be displayed in Window C. The instrument will continue to make automatic continuous sweeps. While the instrument is sweeping, it will not respond to any of the front panel keys except the **SWEEP** key. Continuous sweeping can be stopped by pressing the **SWEEP** key. A sweep that has been stopped can be continued from the stopping point by pressing **SHIFT RECALL** or it can be started over from the beginning by pressing **SWEEP**.

Uncorrected Measurement

An uncorrected measurement can be performed by eliminating the Second Stage Calibration or by pressing the **F** key before initiating the sweep.

Fixed Frequency Measurements

To make a fixed frequency (single frequency) measurement instead of swept frequency, insert the following variations into the procedure above. (The example given is for a fixed frequency measurement at 13000 MHz.)

a. In place of Step 8, press:

FIXED FREQ 13000 ENTER

b. Do not perform Steps 9 and 10.

c. In place of Step 18, Calibration, press:

SHIFT CALIB

This initiates a calibration at the fixed frequency.

3-16. PROCEDURE FOR TEST CONFIGURATION 4 (FOR SINGLE SIDEBAND MEASUREMENTS)

Description

This configuration is used for measurements when:

1. The DUT is a receiver-type device.
2. The DUT output frequencies (IF) are lower then 1850 MHz.
3. The RF range over which measurements will be taken is less than 1.6 GHz wide. (Measurements are made using single side- band mode only.)
4. The DUT has sharp variations in noise figure across the RF band, such that even a double sideband measurement with a 10 MHz IF is too coarse to resolve the variations.

In this configuration external downconversion is performed in the DUT. The 2075 or an external controller sweeps the variable local oscillator frequency to produce a fixed frequency IF from the Device Under Test.

The local oscillator must be GPIB compatible.

Paragraph 3-44, page 3-95, contains information on PROM stored control programs for external local oscillators. Paragraph 3-45, page 3-96, contains information on writing user defined control programs for external local oscillators.

Equipment Setup

Figures 3-11a and 3-11b are the connection diagrams for calibration and measurement when external relays are not used. An optional setup can be used where external relays, controlled by the 2075, provide the calibration path. (See Paragraph 3-34, page 3-75.)

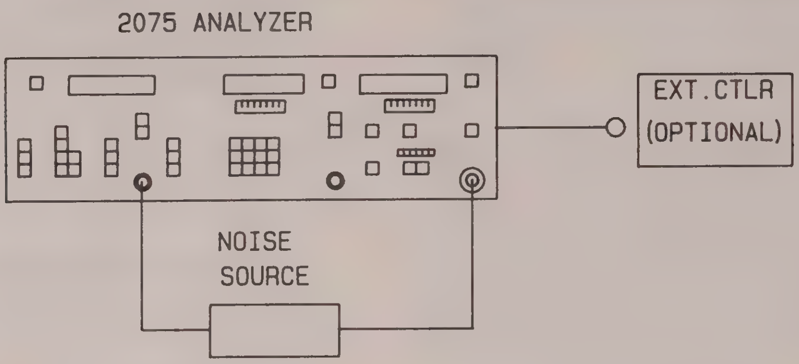


Figure 3-11a. TEST CONFIGURATION 4 CALIBRATION (SINGLE SIDEBAND)

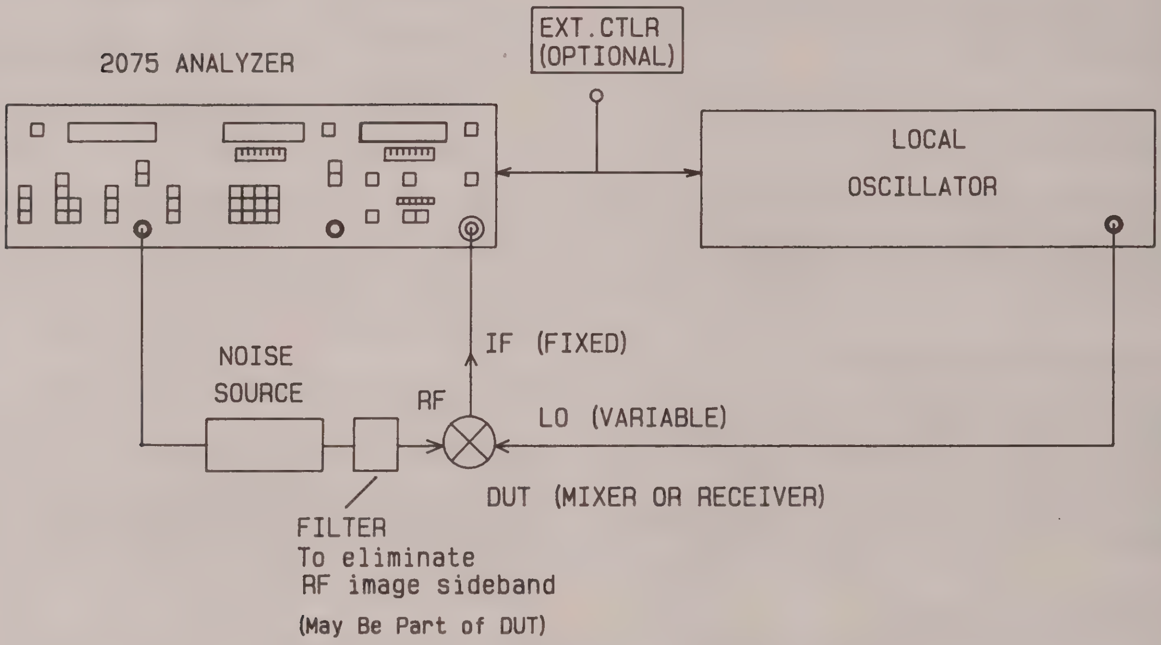


Figure 3-11b. TEST CONFIGURATION 4 MEASUREMENT (SINGLE SIDEBAND)

Procedure

This procedure is used for making corrected Noise Figure and Gain swept measurements. Immediately following the procedure, steps are given for making fixed frequency corrected Noise Figure and Gain measurements. In Paragraphs 3-19 through 3-28, steps are given for making other measurements such as Effective Input Noise Temperature, Y-Factor, etc.

1. Connect the test equipment as shown in the calibration setup of Figure 3-11a or the optional setup using external relays.

2. Apply AC power to the 2075.

3. Press:

   PRESET

   GPIB: Device Clear or Selective Device Clear

   This sets the front panel control parameters to preset values. (See Paragraph 3-4.)

4. Perform the procedure of Paragraph 3-9 to enter frequency/ENR values unless this has previously been done.

5. Press:

   SPEC FUNC | 1.4 | ENTER

   GPIB: D4

   This selects test configuration 4.

6. Perform the following steps if they apply:

   a. Enter the cold temperature of the noise source. (See Paragraph 3-41, page 3-88.)

   b. Enter any losses before or after the DUT. (See Paragraph 3-40, page 3-86.)

   c. Employ bandwidth compensation if required. (See Paragraph 3-38, page 3-82.)

7. Press:

   SPEC FUNC | 14.1 | ENTER

   GPIB: T1

   This will activate the HOLD function. This prevents the 2075 from making measurements before all the front panel control parameters have been entered.

8. To enter the sweep start RF frequency (for example, 8000 MHz), press:

   START FREQ | 8000 | ENTER

   GPIB: FA8000MZ

9. To enter the sweep stop RF frequency (for example, 9200 MHz), press:

   STOP FREQ | 9200 | ENTER

   GPIB: FB9200MZ

10. To enter the frequency step size (for example, 25 MHz), press:

    STEP SIZE | 25 | ENTER

    GPIB: SS25MZ

11. To enter the fixed IF frequency (for example, 1700 MHz), press:

    SHIFT | START FREQ | 1700 | ENTER

    GPIB: IF1700MZ

12. To select the desired single sideband parameter (In this example, lower sideband), press:

    SPEC FUNC | 2.1 | ENTER

    GPIB: A1

    Upper sideband would be:

    SPEC FUNC | 2.2 | ENTER

    GPIB: A2

13. To select the correct program for controlling the external local oscillator (for example, an HP8350 local oscillator), press:

SPEC FUNC 47.3 ENTER

See Paragraphs 3-44 and 3-45 for information on control programs for external local oscillators.

14. To set the local oscillator power level (Always entered in dBm. In this example it is 6 dBm.), press:

SHIFT ⇧ 6 ENTER

15. To enter the local oscillator settling time, which allows the local oscillator to stabilize at each frequency (Always entered in milliseconds. In this example it is 20 ms.), press:

SPEC FUNC 3.1 ENTER

20 ENTER

16. To enter the GPIB address for the external local oscillator (In this example it is 17), press:

SHIFT LOCAL 17 ENTER

17. To make the 2075 the controller and enable the program which will control the local oscillator, press:

SPEC FUNC 40.2 ENTER

18. To calibrate the setup, press: (For information on smoothing, see Paragraph 3-49 on page 3-110.)

CALIB

GPIB: CA

This initiates the Second Stage Calibration which measures and stores the Noise Figure of the entire setup, including the Noise Figure of the 2075. First a frequency calibration (FCAL) is done and then a CAL0, CAL1, CAL2, and CAL3. In this case the calibration is done at the fixed IF frequency of 1700 MHz. When external relays are used to provide the calibration path, the 2075 automatically applies voltage to the relays when the **CALIB** key is pressed.

19. Deactivate the HOLD function by pressing:

SPEC FUNC 14.0 ENTER

GPIB: T0

When the HOLD is deactivated, the 2075 automatically begins making fixed frequency measurements of corrected Noise Figure and Gain at the start frequency, which in this case is 8000 MHz. It makes corrected measurements, as opposed to uncorrected measurements, because the Second Stage Calibration has been performed. It makes fixed frequency measurements, as opposed to swept measurements, because the fixed frequency mode is the default mode, and swept mode has not yet been selected.

20. Insert the Device Under Test into the setup, as shown in Figure 3-10b. If external relays are being used, ignore this step. Upon completing the calibration, the 2075 removes the actuating voltage from the relays to place the DUT in the measurement path (unless Special Function 10.1 has been activated).

21. To initiate a single swept measurement, press:

SHIFT SWEEP

GPIB: SG

As the 2075 steps through the band each RF frequency will be displayed in Window A, each corrected Gain value will be displayed in Window B, and each corrected Noise Figure value will be displayed in Window C. One single sweep is executed and, when completed, the 2075 remains tuned to the stop frequency.

22. To initiate continuous swept measurements, press:

SWEEP

GPIB: SR

As the 2075 steps through the band each RF frequency will be displayed in Window A, each corrected Gain value will be displayed in Window B, and each corrected Noise Figure value will be displayed in Window C. The instrument will continue to make automatic continuous sweeps. While the instrument is sweeping, it will not respond to the front panel keys except for the **SWEEP** key. Continuous sweeping can be stopped by pressing the **SWEEP** key. A sweep that has been stopped can be continued from the stopping point by pressing **SHIFT RECALL** or it can be started over from the beginning by pressing **SWEEP**.

Uncorrected Measurement

An uncorrected measurement can be performed by eliminating the Second Stage Calibration or by pressing the **F** key before initiating the sweep.

Fixed Frequency Measurements

To make a fixed frequency (single frequency) measurement instead of swept frequency, insert the following variations into the procedure above. (The example given is for a fixed frequency measurement at 9000 MHz.)

a. In place of Step 8, press:

FIXED FREQ | 9000 | ENTER

b. Do not perform Steps 9 and 10.

c. In place of Step 18, Calibration, press:

SHIFT | CALIB

This initiates a calibration at the fixed frequency.

3-17. PROCEDURE FOR TEST CONFIGURATION 5 (SINGLE SIDEBAND)

Description

This configuration is used for measurements when:

1. The DUT is a receiver-type device.
2. The DUT output frequencies (IF) are lower than 1850 MHz.
3. The RF range over which measurements will be made is less than 1.6 GHz wide. (Measurements are made using single sideband mode only.)
4. A GPIB compatible local oscillator is not available.

In this configuration external downconversion is performed in the DUT. The local oscillator frequency is fixed and need not be controlled by the 2075 or by an external controller. However, if a GPIB compatible local oscillator is available, its fixed frequency and its power level can be controlled by the 2075 or an external controller. In either case, the IF output from the Device Under Test varies. The 2075 sweeps to tune to the variable frequency IF from the external mixer.

NOTE

When using Test Configuration 5 for lower single sideband measurements, always use a step size which gives an integral number of steps from the start frequency to the stop frequency.

Equipment Setup

Figures 3-12a and 3-12b are the connection diagrams for calibration and measurement when external relays are not used. An optional setup can be used where external relays, controlled by the 2075, provide the calibration path. (See Paragraph 3-34, page 3-75.)

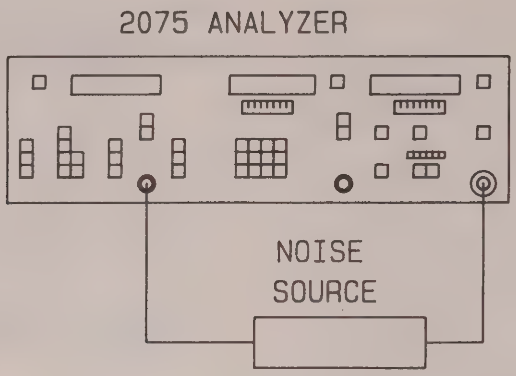


Figure 3-12a. TEST CONFIGURATION 5 CALIBRATION

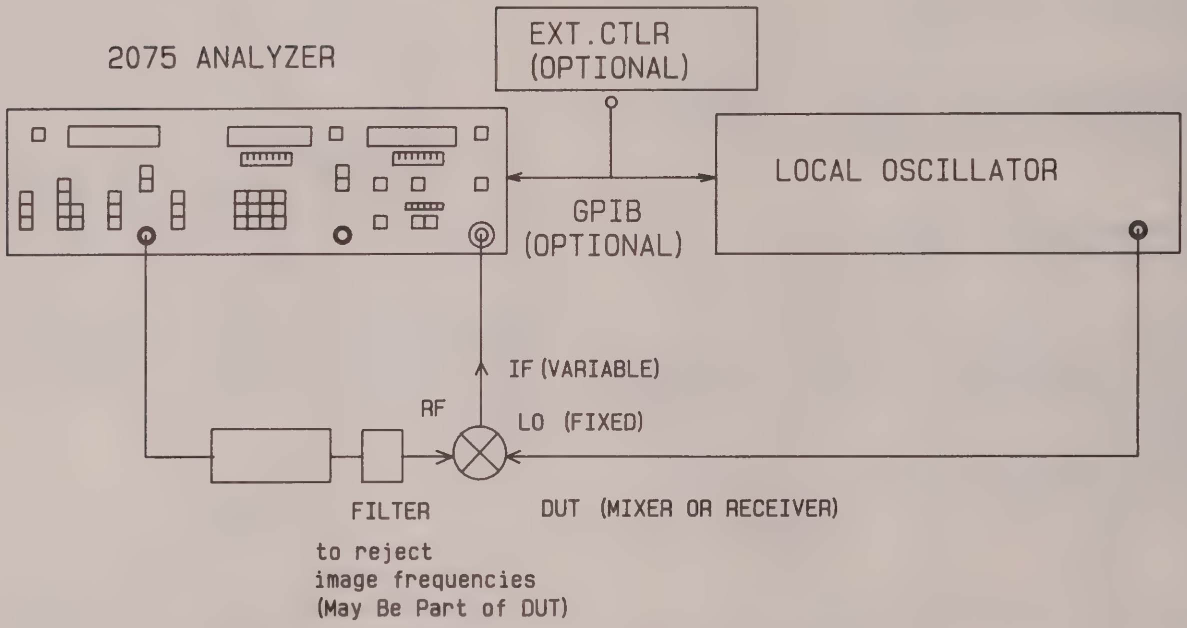


Figure 3-12b. TEST CONFIGURATION 5 MEASUREMENT

Procedure

This procedure is used for making corrected Noise Figure and Gain swept measurements. Immediately following the procedure, steps are given for making fixed frequency corrected Noise Figure and Gain measurements. In Paragraphs 3-19 through 3-28, steps are given for making other measurements such as Effective Input Noise Temperature, Y-Factor, etc.

1. Connect the test equipment as shown in the calibration setup of Figure 3-12a or the optional setup using external relays.

2. Apply AC power to the 2075.

3. Press:

PRESET

GPIB: Device Clear or Selective Device Clear

This sets the front panel control parameters to preset values. (See Paragraph 3-4.)

4. Perform the procedure of Paragraph 3-9 to enter Frequency/ENR values unless this has previously been done.

5. Press:

SPEC FUNC	1.5	ENTER

GPIB: D5

This selects Test Configuration 5.

6. Perform the following steps if they apply:

    a. Enter the cold temperature of the noise source. (See Paragraph 3-41, page 3-88.)

    b. Enter any losses before or after the DUT. (See Paragraph 3-40, page 3-86.)

    c. Employ bandwidth compensation if required. (See Paragraph 3-38, page 3-82.)

7. Press:

SPEC FUNC	14.1	ENTER

GPIB: T1

This will activate the HOLD function which prevents the 2075 from making measurements before all the front panel control parameters have been entered.

8. To enter the sweep start RF frequency (for example, 10010 MHz), press:

START FREQ	10010	ENTER

GPIB: FA10010MZ

9. To enter the sweep stop RF frequency (for example, 11000 MHz), press:

STOP FREQ	11000	ENTER

GPIB: FB11000MZ

10. To enter the frequency step size (for example, 20 MHz), press:

STEP SIZE	20	ENTER

GPIB: SS20MZ

11. To enter the fixed local oscillator frequency (for example, 9510 MHz), press:

SHIFT	STOP FREQ	9510	ENTER

GPIB: LO9510MZ

12. To select the desired single sideband parameter (In this example, upper sideband), press:

SPEC FUNC	2.2	ENTER

GPIB: A2

Lower sideband would be:

SPEC FUNC   2.1   ENTER

GPIB: A1

Perform Steps 13 through 16 only if the external local oscillator is under GPIB control. Otherwise, go to Step 17.

13. To select the correct program for controlling the external local oscillator (for example, a Wiltron 6600 local oscillator), press:

    SPEC FUNC   47.1   ENTER

    See Paragraphs 3-44 and 3-45 for information on control programs for external local oscillators.

14. To set the local oscillator power level (Always entered in dBm. In this example it is 6 dBm.), press:

    SHIFT   ⇧   6   ENTER

15. To enter the GPIB address for the external local oscillator (In this example the address is 17), press:

    SHIFT   LOCAL   17   ENTER

16. To make the 2075 the controller and enable the program which will control the local oscillator, press:

    SPEC FUNC   40.2   ENTER

17. To calibrate the setup, press:
    (For information on smoothing, see Paragraph 3-49 on page 3-110.)

    CALIB

    GPIB: CA

    This initiates the Second Stage Calibration which measures and stores the Noise Figure of the entire setup, including the internal Noise Figure of the 2075. First a frequency calibration (FCAL) is done and then a CAL0, CAL1, CAL2, and CAL3. The frequency parameters previously entered determine the frequency points for the calibration. In this case the calibration is done at the IF frequencies from 500 MHz to 1490 MHz, at 20 MHz steps. When external relays are used to provide the calibration path, the 2075 automatically applies voltage to the relays when the **CALIB** key is pressed.

18. Deactivate the HOLD function by pressing:

    SPEC FUNC   14.0   ENTER

    GPIB: T0

    When the HOLD is deactivated, the 2075 automatically begins making fixed frequency measurements of corrected Noise Figure and Gain at the start frequency, which in this case is 10010 MHz. It makes corrected measurements, as opposed to uncorrected measurements, because the Second Stage Calibration has been performed. It makes fixed frequency measurements, as opposed to swept measurements, because the fixed frequency mode is the default mode, and swept mode has not yet been selected.

19. Insert the Device Under Test into the setup, as shown in Figure 3-12b. If external relays are being used, ignore this step. Upon completing the calibration, the 2075 removes the actuating voltage from the relays to place the DUT in the measurement path (unless Special Function 10.1 has been activated).

20. To initiate a single swept measurement, press:

    SHIFT   SWEEP

    GPIB: SG

As the 2075 steps from the IF's of 500 to 1490 MHz in steps of 20 MHz, it will display the actual RF frequencies from 10010 MHz to 11000 MHz in Window A. Each corrected Gain value will be displayed in Window B, and each corrected Noise Figure value will be displayed in Window C. One single sweep is executed and when completed, the 2075 remains tuned to the stop frequency.

21. To initiate continuous swept measurements press:

SWEEP GPIB: SR

As the 2075 steps from the IF's of 500 to 1490 MHz in steps of 20 MHz, it will display the actual RF frequencies from 10010 MHz to 11000 MHz in Window A, each corrected Gain value will be displayed in Window B, and each corrected Noise Figure value will be displayed in Window C. The instrument will continue to make automatic continuous sweeps. While the instrument is sweeping, it will not respond to any front panel keys except for the **SWEEP** key. Continuous sweeping can be stopped by pressing the **SWEEP** key. A sweep that has been stopped can be continued from the stopping point by pressing **SHIFT RECALL** or it can be started over from the beginning by pressing **SWEEP**.

Uncorrected Measurement

An uncorrected measurement can be performed by eliminating the Second Stage Calibration or by pressing the **F** key before initiating the sweep.

Fixed Frequency Measurements

To make a fixed frequency (single frequency) measurement instead of swept frequency, insert the following variations into the procedure above. (The example given is for a fixed frequency measurement at 10400 MHz.)

a. In place of Step 8, press:

FIXED FREQ 10400 ENTER

b. Do not perform Steps 9 and 10.

c. In place of Step 17, Calibration, press:

SHIFT CALIB

This initiates a calibration at the fixed frequency.

3-18. PROCEDURE FOR TEST CONFIGURATION 6

Description

This configuration is used for measurements when:

1. The DUT is a receiver-type device.
2. The DUT output frequencies (IF) are higher than 1850 MHz.

In this configuration two stages of external downconversion are performed. The first stage of external downconversion is performed in the DUT. A fixed frequency local oscillator (usually an integral part of the DUT) drives the DUT to produce a variable frequency IF output higher than 1850 MHz. This local oscillator is not controlled by the 2075.

The second stage of external downconversion is performed in an external mixer. This mixer is driven by a variable frequency local oscillator which is controlled by the 2075 or an external controller. This mixer has, as its second input, the variable IF from the DUT. The output of this mixer is a fixed IF frequency below 1850 MHz.

Note that the measurement must be either upper or lower single sideband. Therefore, if the DUT does not have the proper filtering in its front end (most receivers do), then a filter must be placed in front of the DUT to reject the unwanted image sideband. Also note that this filter is not part of the second stage, so its loss must be accounted for by using loss compensation (Section 3-40, page 3-86). The isolator in Figures 13a and 13b, prevents unwanted interaction between the mixer and the DUT, and is part of the second stage.

Paragraph 3-44, page 3-95, contains information on

PROM stored control programs for external local oscillators. Paragraph 3-45, page 3-96, contains information on writing user defined control programs for external local oscillators.

NOTE

> When using Test Configuration 6 for lower single sideband measurements, always use a step size which gives an integral number of steps from the start frequency to the stop frequency.

Even though the measurement is always single sideband with respect to the RF (Figure 3-13b), the 2075 actually makes a double sideband measurement with respect to the IF of the DUT (IF_2 in Figure 3-13b). Therefore the IF entered in step 12 of the procedure (IF_1 in Figure 3-13b) must be a low frequency suitable for a double sideband measurement.

Equipment Setup

Figures 3-13a and 3-13b are the connection diagrams for calibration and measurement when external relays are not used. An optional setup can be used where external relays, controlled by the 2075, provide the calibration path. (See Paragraph 3-34, page 3-75.)

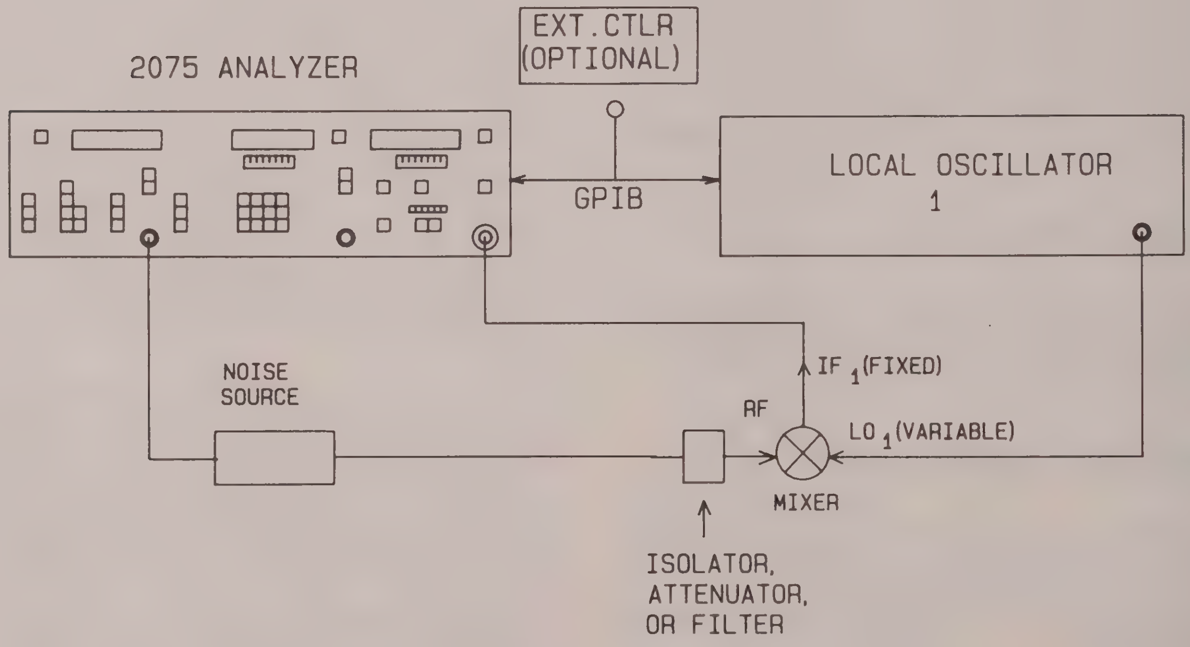


Figure 2

Figure 3-13a. TEST CONFIGURATION 6 CALIBRATION

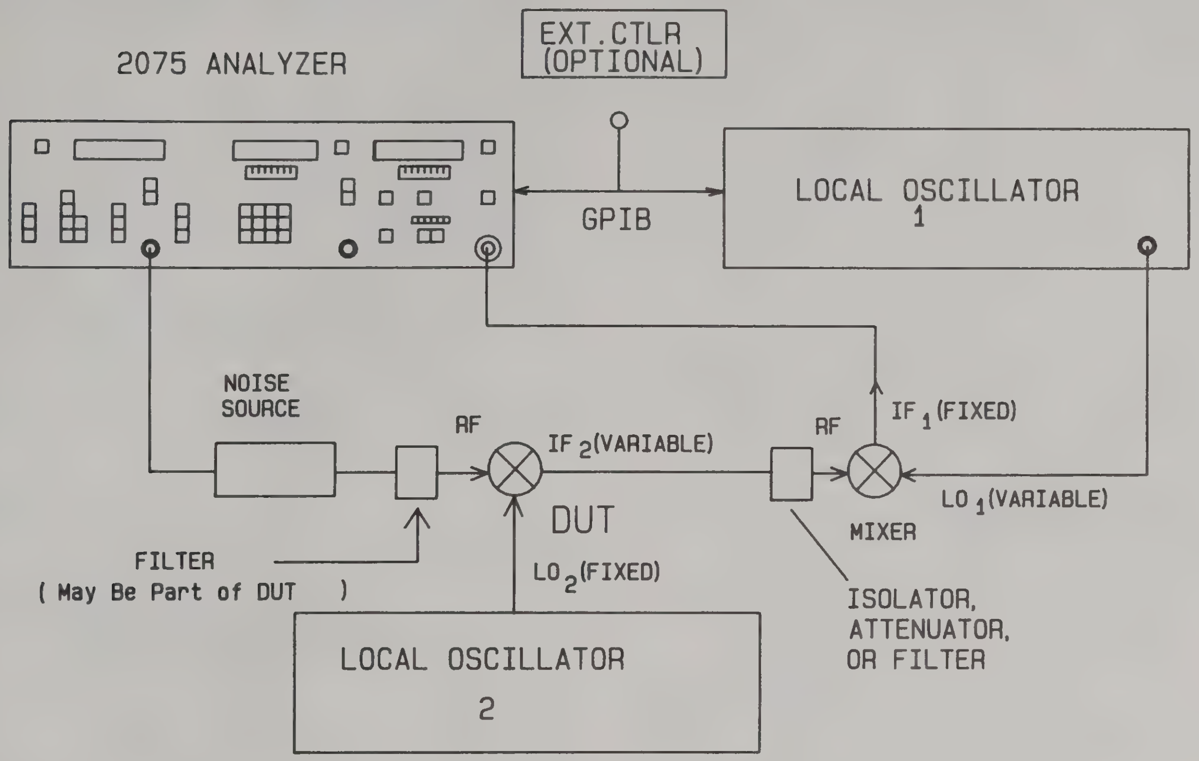


Figure 3-13b. TEST CONFIGURATION 6 MEASUREMENT

Procedure

This procedure is used for making corrected Noise Figure and Gain swept measurements. Immediately following the procedure, steps are given for making fixed frequency corrected Noise Figure and Gain measurements. In Paragraphs 3-19 through 3-28, steps are given for making other measurements such as Effective Input Noise Temperature, Y-Factor, etc.

1. Connect the test equipment as shown in the calibration setup of Figure 3-13a or the optional setup using external relays.
2. Apply AC power to the 2075.
3. Press:

   PRESET

   GPIB: Device Clear or Selective Device Clear

   This sets the front panel control parameters to preset values. (See Paragraph 3-4.)
4. Perform the procedure of Paragraph 3-9 to enter Frequency/ENR values unless this has previously been done.
5. Press:

   SPEC FUNC 1.6 ENTER

   GPIB: D6

   This selects Test Configuration 6.
6. Perform the following steps if they apply:

   a. Enter the cold temperature of the noise source. (See Paragraph 3-41, page 3-88.)

   b. Enter any losses before or after the DUT. (See Paragraph 3-40, page 3-86.)

c. Employ bandwidth compensation if required. (See Paragraph 3-38, page 3-82.)

7. Press:

SPEC FUNC 14.1 ENTER

GPIB: T1

This will activate the HOLD function. This prevents the 2075 from making measurements before all the front panel control parameters have been entered.

8. To enter the sweep start RF frequency (for example, 42000 MHz), press:

START FREQ 42000 ENTER

GPIB: FA42000MZ

9. To enter the sweep stop RF frequency (for example, 46000 MHz), press:

STOP FREQ 46000 ENTER

GPIB: FB46000MZ

10. To enter the frequency step size (for example, 100 MHz), press:

STEP SIZE 100 ENTER

GPIB: SS100MZ

11. To enter the fixed frequency of the DUT integral local oscillator (for example, 39000 MHz), press:

SHIFT ⇩ 39000 ENTER

GPIB: SL39000MZ

12. To enter the fixed IF output frequency from the external mixer (for example, 20 MHz), press:

SHIFT START FREQ 20 ENTER

GPIB: IF20MZ

13. To select the desired single sideband parameter (In this example upper sideband), press:

SPEC FUNC 2.2 ENTER

GPIB: A2

Lower sideband would be:

SPEC FUNC 2.1 ENTER

GPIB: A1

14. To select the correct program for controlling the external local oscillator (for example, a Wiltron 6600 local oscillator), press:

SPEC FUNC 47.1 ENTER

See Paragraphs 3-44 and 3-45 for information on control programs for external local oscillators.

15. To set the local oscillator power level (Always entered in dBm. In this example it is 6 dBm.), press:

    SHIFT ⇧ 6 ENTER

16. To enter the local oscillator settling time, which allows the local oscillator to stabilize before each measurement is made (Always entered in milliseconds. In this example it is 20 ms.), press:

    SPEC FUNC 3.1 ENTER

    20 ENTER

    GPIB: ST20

17. To enter the GPIB address for the external local oscillator, LO 1 in Figure 3-13 (in this example the address is 17) press:

    SHIFT LOCAL 17 ENTER

18. To make the 2075 the controller and enable the program which will control the local oscillator press:

    SPEC FUNC 40.2 ENTER

    Refer to paragraphs 3-44 and 3-45 for information on control programs.

19. To calibrate the setup, press:
    (For information on smoothing, see Paragraph 3-49 on page 3-110.)

    CALIB

    GPIB: CA

    This initiates the Second Stage Calibration which measures and stores the Noise Figure of the entire setup, including the internal Noise Figure of the 2075. First an FCAL (frequency calibration) is done and then a CAL0, CAL1, CAL2, and CAL3. The frequency parameters entered previously determine the frequency points for the calibration. In this case the calibration is done at variable IF frequencies from 3000 MHz to 7000 MHz in 100 MHz steps. When external relays are used to provide the calibration path, the 2075 automatically applies voltage to the relays when the **CALIB** key is pressed.

20. Deactivate the HOLD function by pressing:

    SPEC FUNC 14.0 ENTER

    GPIB: T0

    When the HOLD is deactivated, the 2075 automatically begins making fixed frequency measurements of corrected Noise Figure and Gain at the start frequency, which in this case is 42000 MHz. It makes corrected measurements, as opposed to uncorrected measurements, because the Second Stage Calibration has been performed. It makes fixed frequency measurements, as opposed to swept measurements, because the fixed frequency mode is the default mode, and swept mode has not yet been selected.

21. Insert the Device Under Test into the setup, as shown in Figure 3-13b. If external relays are being used, ignore this step. Upon completing the calibration, the 2075 removed voltage from the relays to place the DUT in the measurement path (unless Special Function 10.1 has been activated).

22. To initiate a single swept measurement, press:

    SHIFT SWEEP

    GPIB: SG

    As the 2075 sweeps from the 42000 to 46000 MHz in steps of 100 MHz, it will display the actual RF frequency in Window A. Each corrected Gain value will be displayed in Window B, and each corrected Noise Figure value will be displayed in Window C. One single sweep is executed and when completed, the 2075 remains tuned to the stop frequency.

23. To initiate continuous swept measurements, press:

SWEEP GPIB: SR

As the 2075 sweeps from 42000 to 46000 MHz in steps of 100 MHz, it will display the actual RF frequency in Window A. Each corrected Gain value will be displayed in Window B, and each corrected Noise Figure value will be displayed in Window C. The instrument will continue to make automatic continuous sweeps. While the instrument is sweeping, it will not respond to any front panel keys except the **SWEEP** key. Continuous sweeping can be stopped by pressing the **SWEEP** key. A sweep that has been stopped can be continued from the stopping point by pressing **SHIFT RECALL** or it can be started over from the beginning by pressing **SWEEP**.

Uncorrected Measurement

An uncorrected measurement can be performed by eliminating the Second Stage Calibration or by pressing the **F** key before initiating the sweep.

Fixed Frequency Measurements

To make a fixed frequency (single frequency) measurement instead of swept frequency, insert the following variations into the procedure above. (The example given is for a fixed frequency measurement at 42500 MHz.)

a. In place of Step 8, press:

FIXED FREQ 42500 ENTER

b. Do not perform Steps 9 and 10.

c. In place of Step 19, Calibration, press:

SHIFT CALIB

This initiates a calibration at the fixed frequency.

3-19. ADDITIONAL TYPES OF MEASUREMENTS

In addition to Noise Figure and Gain measurements, the 2075 can make other noise related measurements. These are listed below in Table 3-5. Note that some of these measurements can be made in cascade (uncorrected) only, some can be made as First Stage (corrected) only, and some can be made either way.

Table 3-5. Additional Measurements

MEASUREMENT	SYMBOL	MODE
Effective Input Noise Temperature	T_e	Cascade or First Stage
Y-Factor	Y	Cascade only
Operating Noise Temperature	T_{op}	Cascade or First Stage
Power	dB PWR	First Stage only
ENR	dB PWR	First Stage only
Noise Measure	M	First Stage only

The detailed measurement procedures given for each test configuration (Paragraphs 3-11 through 3-18) are the basic procedures for any automatic measurement. It is always necessary to select the correct test configuration, to enter frequency parameters, etc. Second Stage Calibration must always be performed before a corrected measurement is made. The basic difference in performing one type of noise measurement instead of another, is in the keystroke sequence which selects the type of measurement. For example, to select T_{op}, the keys **SPEC FUNC 11.2 ENTER** are pressed. To select M, the keys **SPEC FUNC 11.5 ENTER** are pressed. After the specific measurement is selected, it is executed in the same manner as in the basic procedures. That is, the **SHIFT SWEEP** or **SWEEP** keys must be pressed to execute single or continuous swept measurements. Although the basic procedures do not vary in most cases, some additional or different steps may be required for a particular type of measurement. The following paragraphs present the pertinent details and procedural differences where required for each type.

3-20. EFFECTIVE INPUT NOISE TEMPERATURE (T_e) MEASURMENT

Effective Input Noise Temperature (T_e) is the noise temperature at the input of a noiseless equivalent of the DUT that would cause the noiseless DUT to have the same noise output as the actual DUT. T_e is always measured in kelvins. It is related to Noise Figure by the equation:

$$T_e = (F - 1) \times 290 \text{ (kelvins)}$$

Where F is the noise figure expressed as a ratio.

When measuring T_e there is no change in the basic measurement setup or procedure.

To make a cascade measurement of T_e, press:

SHIFT F GPIB: TE

To make a first stage (corrected) measurement of T_e, after Second Stage Calibration, press:

SHIFT F+G GPIB: TG

Then press the appropriate keys to make single or continuous swept measurement. The result is displayed in Window C and is always expressed in kelvins. Window B will display the Gain of the DUT in dB or as a ratio.

3-21. Y-FACTOR (Y) MEASUREMENT

Y-Factor is a ratio of the noise power output from the DUT when the noise source is ON (or hot) to the noise power output from the DUT when the noise source is OFF (or cold). It can be expressed as dB or as a ratio.

Y-Factor measurement can be made as an automatic or as a manual measurement. The automatic procedure is given below. The manual procedure is given in Paragraph 3-28. Y-Factor is always a cascade measurement and so Second Stage Calibration is not required.

When measuring Y-Factor there is no change in the basic measurement setup or procedure as given for each test configuration.

To measure Y-Factor, press:

SPEC FUNC 11.1 ENTER

Then press the **SWEEP** or **SHIFT SWEEP** keys to execute single or continuous swept measurement. The results will be displayed in Window C. The measurement can be displayed as dB or as a ratio by pressing the **dB/RATIO** key.

3-22. OPERATING NOISE TEMPERATURE (T_{op}) MEASUREMENT

Operating Noise Temperature is a measure of the total noise of a receiving system, including the antenna noise, when it is situated in its normal operating environment. T_{op} is related to the Effective Input Noise Temperature by the equation:

$$T_{op} = T_e + T_a$$

Where T_a is the noise temperature of the antenna.

T_{op} measurements can be made as cascade or as first stage measurements. Figures 3-14a and b below show the equipment configurations for calibration and measurement. Although the figures show an example using Test Configuration 1, any appropriate test configuration can be used.

When making T_{op} measurements, Loss Compensation may be employed to compensate for the coupler attenuation factor. Because this coupling attenuation occurs between the noise source and the DUT, it is entered as Loss 1, using Special Function 18.1. For detailed information on Loss Compensation refer to Paragraph 3-40.

The temperature of the loss, which is the ambient temperature, is entered using Special Function 18.2.

If there is a loss following the DUT, and it is not part of the second stage, it must be entered as Loss 2. If there is a loss following the DUT, but it is part of the second stage, enter a value of 0 for Loss 2. Loss 2 is entered using Special Function 18.3

Although Special Functions 18.1, 18.2, and 18.3 must be used to enter the loss values, it is not necessary to enter Special Function 17.1 to activate the loss compensation function. It will be activated automatically when the T_{op} measurement is done.

After the loss compensation values have been entered, perform the Second Stage Calibration (if a corrected measurement is desired).

Special Function 11.2 is entered to select the T_{op} measurement.

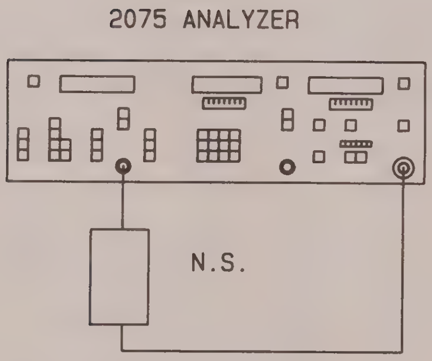


Figure 3-14a. T_{op} SETUP-CALIBRATION

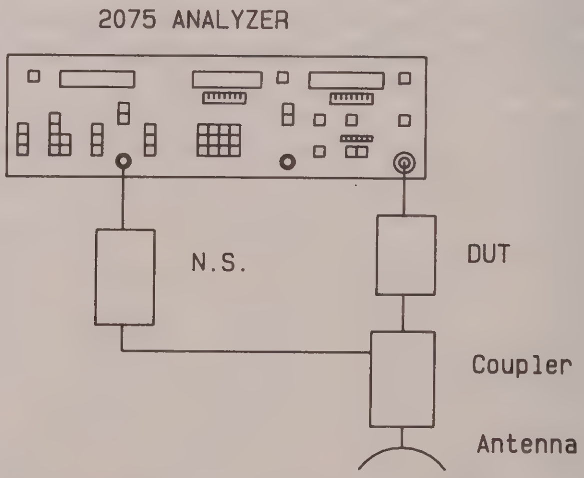


Figure 3-14b. T_{op} SETUP-MEASUREMENT

The 2075 will make a corrected or uncorrected measurement depending on which mode it is in when the measurement is performed. A single swept measurement is executed by pressing the **SHIFT** and **SWEEP** keys. Continuous swept measurements are executed by pressing the **SWEEP** key. If Second Stage Calibration has just been performed, the 2075 will be in the corrected measurement mode, and will make a first stage measurement. If no Second Stage Calibration has been performed, it will make an uncorrected measurement.

However, if the calibration has been performed, and an uncorrected measurement is desired, put the instrument back in uncorrected mode by pressing the **F** key. Then press the approriate keys to execute the measurement. Alternately, to get back to the corrected measurement mode, press the **F + G** key. Then press the appropriate keys to make the measurement.

The following example is given to show the steps which are added to the basic measurement procedure.

1. To enter the coupler attenuation as Loss 1 (for example, 10 dB), press:

   SPEC FUNC   18.1   ENTER

   10   ENTER

2. To enter the loss temperature (for example, 296 kelvins), press:

   SPEC FUNC   18.2   ENTER

   296.5   ENTER

3. To enter Loss 2 (for example, 0 dB), press:

   SPEC FUNC   18.3   ENTER

   0   ENTER

4. Perform the Second Stage Calibration in the normal manner.

5. To select the measurement, press:

   SPEC FUNC   11.2   ENTER

6. To make the measurement, press the apropriate keys which select single sweep or continuous sweeps (per the basic procedure).

The measurement results will be displayed in Window C. The units of display are kelvins.

GPIB codes: Special Function 18.1 is L1
Special Function 18.2 is L2
Special Function 18.3 is L3
Special Function 11.2 is OP

3-23. POWER (dB) MEASUREMENTS

Measurements of noise power density relative to −174 dBm/Hz can be made using Special Functions 11.3 and 11.4. Minus 174 dBm is the thermal noise level at 290 kelvins for a 1 Hz bandwidth. The noise power density measurements made by the 2075 are displayed in dB, relative to this −174 dBm/Hz level. The equation is as follows:

$$\text{Power (dB)} = 10 \log \frac{(T_{\text{unknown}})}{T_0}$$

Where T_0 is the 290 K reference temperature and T_{unknown} equals the temperature which is proportional to the unknown power density.

This measurement can be made either as an uncorrected or a corrected measurement. The uncorrected measurements assume a nominal noise figure value of 6 dB for the second stage. Uncorrected measurements are not accurate and are not recommended.

When making a power measurement, perform the basic procedure as given for the appropriate test configuration. Perform the procedure up to and including the Second Stage Calibration. Then place the DUT in the setup and perform the following steps:

To select the measurement with the noise source OFF, press:

SPEC FUNC | 11.3 | ENTER

To select the measurement with the noise source ON, press:

SPEC FUNC | 11.4 | ENTER

Then press the approriate key to execute the swept measurement. The measurement results, in each case, are displayed in Window C. The units of display are dB relative to 290 kelvins (-174 dBm/Hz).

The GPIB code for Special Function 11.3 is PM
The GPIB code for Special Function 11.4 is PN

3-24. ENR MEASUREMENT

The 2075 can be used to measure the ENR values of a noise source. In this procedure, Second Stage Calibration is performed using a noise source with known ENR values. The noise source with unknown values is then installed in the test setup and measured using Special Function 11.6. The calculation for this measurement is:

$$ENR = 10 \log \frac{T_h - 290}{290}$$

Where T_h is the hot or ON temperature of the noise source being measured.

The calibration and measurement setups are shown in Figures 3-15a and b below. The illustrations are for Test Configuration 1, however the measurement can be performed using any configuration, as required, depending upon measurement frequency.

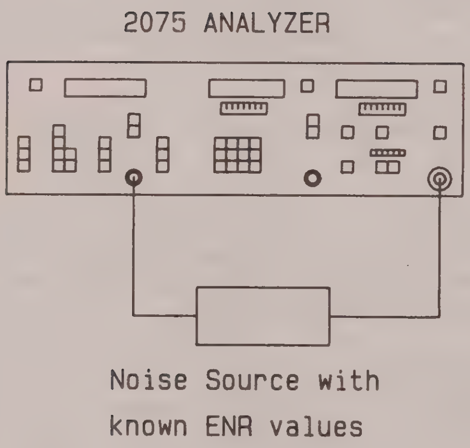


Figure 3-15a. ENR SETUP - CALIBRATION

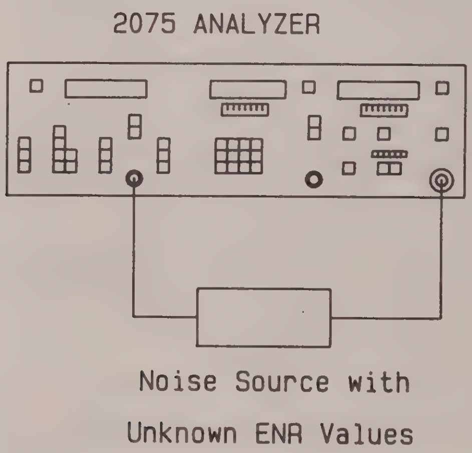


Figure 3-15b. ENR SETUP - MEASUREMENT

Perform the steps as given in the detailed procedure for the appropriate test configuration up to and including the Second Stage Calibration. Then perform the following steps:

To select the ENR measurement, press:

SPEC FUNC 11.6 ENTER

Connect the noise source with unknown ENR values in place of the noise source with known values (Figure 3-15b).

Press the appropriate keys to make a single sweep or continuous swept measurements. The results will be displayed in Window C and the dB PWR annunciator will be lit. The units of display are dB but can be changed to a ratio by pressing the **dB/RATIO** key.

3-25. NOISE MEASURE (M) MEASUREMENT

Noise Measure (M) is a parameter which includes both Noise Figure and Gain. This parameter is typically used by transistor manufacturers as a figure of merit. The formula for computing M is as follows:

$$M = \frac{(F - 1)}{1 - 1/G}$$

Where F = Noise Figure of the DUT expressed as a ratio and G = Gain of the DUT expressed as a ratio.

Noise Measure can be performed only as a corrected measurement.

The basic measurement procedure does not change from those given for each test configuration. Perform the steps up to and including Second Stage Calibration and then install the DUT in the setup. Select M by pressing:

SPEC FUNC 11.5 ENTER

Press the appropriate keys to execute a swept measurement. The measurement results for M will be displayed in Window C. The results for Gain will be displayed in Window B.

3-26. MANUAL MEASUREMENTS

The 2075 can make manual measurements of Noise Figure and Gain or Y-Factor. A true hot/cold thermal noise source is generally used for manual measurement of Noise Figure and Gain. A continuously variable, precision, calibrated attenuator is required for manual Y-Factor measurements. Manual measurements can be made only at fixed frequencies.

The following paragraphs detail the procedures for manual measurement of Noise Figure and Gain, and Y-Factor.

3-27. MANUAL MEASUREMENT OF NOISE FIGURE AND GAIN

A true hot/cold noise source, such as the Eaton 7009, is generally used for this measurement. The following procedure is for making a corrected measurement. An uncorrected measurement of Noise Figure can be made by omitting Steps 7 through 10.

1. Enter the T_{hot} value, in kelvins, of the hot noise source. For example, if the T_{hot} value is 373 kelvins, press:

   SHIFT ENR 373 ENTER

   (The Preset value of T_{hot} is 9893 K. The current value for T_{hot} is displayed in Window B as soon as the **SHIFT** and **ENR** keys are pressed.)

   Special Function 12 can be set to 12.1 to allow temperature entries to be made in Centrigrade or it can be set to 12.2 to allow entries in Fahrenheit.

2. Enter the T_{cold} value, in kelvins, of the cold noise source. For example, if the T_{cold} value is 78 kelvins, press:

   SHIFT ON/OFF 78 ENTER

   (The Preset value of T_{cold} is 296 kelvins. The current value for T_{cold} is displayed in Window B as soon as the **SHIFT** and **ON/OFF** keys are pressed.)

   Special Function 12 can be set to 12.1 to allow temperature entries to be made in Centrigrade or it can be set to 12.2 to allow entries in Fahrenheit.

3. Select the desired amount of smoothing by pressing the **RIGHT ARROW** or **LEFT ARROW** keys. To obtain accurate, stable measurements, it is recommended that a smoothing factor of 16 or 32 be employed (4 or 5 LED light bars lit).

4. Tune the 2075 to the desired measurement frequency (for example, 1175 MHz) by pressing:

   FIXED FREQ 1175 ENTER

5. Select the manual measurement mode by pressing:

   SPEC FUNC 6.1 ENTER

   Double hyphens will appear in the front panel displays.

6. Connect the hot noise source to the 2075 RF INPUT.

7. The Second Stage Calibration procedure consists of four steps. Initiate the calibration sequence by pressing:

   CALIB

   The messages FCAL and then CAL0 will appear in Window B. Double bars will be displayed in Window C when this step is completed.

8. Continue the calibration sequence for the hot noise source by pressing:

   ON/OFF

   The messages CAL1, CAL2, CAL3, and then CAL0 will appear in Window B. During this process the green NOISE DRIVE LED will light to indicate that the hot calibration is being performed and Window C will display double bars.

9. Disconnect the hot noise source and connect the cold noise source to the RF INPUT.

10. Complete the calibration sequence by pressing:

    ON/OFF

    The messages CAL1, CAL2, and then CAL3 will appear in Window B. While each of these appears, its calibration noise figure data will be displayed in Window C. During this step the green NOISE DRIVE LED will be extinguished. When this step is completed, the red LED in the **F + G** key will light.

11. The 2075 is now ready to make the measurements.

12. Disconnect the cold noise source.

13. Connect the Device Under Test between the hot noise source and the RF INPUT.

14. Start the hot cycle measurement by pressing:

    ON/OFF

    The hot cycle measurement is completed when the annunciators light in Windows B and C. Double bars will be displayed in Windows B and C, and the green NOISE DRIVE LED will be lit.

15. Disconnect the hot noise source and connect the cold noise source to the DUT.

16. Initiate the cold cycle measurement by pressing:

    ON/OFF

    The green NOISE DRIVE LED will go out and, when the measurement is completed, the Noise Figure value will be displayed in Window C. The Gain will be displayed in Window B.

18. To perform another measurement cycle, repeat Steps 13 through 16.

There are no GPIB codes associated with the manual measurement function except for the special function codes (all special function codes can be sent to the 2075 via GPIB).

Output can be directed to a printer if the printer is in LISTEN ONLY mode and the 2075 is in TALK ONLY mode. Refer to the table of GPIB codes, Table 4-3.

3-28. MANUAL MEASUREMENT OF Y-FACTOR

Measurement of Y-Factor can be accomplished either automatically or manually. The automatic measurement of Y-Factor is accomplished using Special Function 11.1 and the procedure for this method is given in Paragraph 3-21.

Manual measurement of Y-Factor requires a continuously variable precision attenuator such as the Eaton 32 Series. In general, such attenuators are optimized for operation at a single frequency, typically 30 MHz. If the DUT operates at a different frequency, it will be necessary to convert the DUT output frequency to that of the attenuator. Even if frequency conversion is required, the measurement can be performed using Test Configuration 1.

This method gives a very precise result by removing the uncertainties which are due to the 2075. When making this measurement the 2075 is set to voltmeter mode by selecting Special Function 20.1. The measurement can be made only at a fixed frequency.

To make the manual Y-Factor measurement, connect the test equipment as shown in Figure 3-16 below and then perform the steps given.

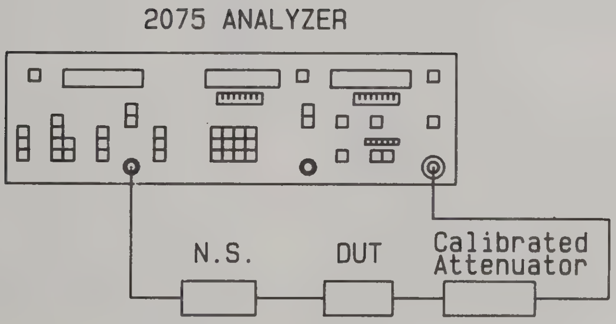


Figure 3-16. MANUAL Y-FACTOR MEASUREMENT

1. Tune the 2075 to the desired frequency of measurement (for example, 70 MHz) by pressing:

   FIXED FREQ | 70 | ENTER

   GPIB: FF70ET

2. To place the 2075 in the voltmeter mode, press:

   SPEC FUNC | 20.1 | ENTER

   GPIB: SP20.1ET

3. Set the attenuator to some value which is greater than the expected Y-Factor measurement value (for example, 15.0 dB). Usually, 15 to 20 dB will be enough. The gain of the DUT plus this initial attenuator setting should be greater than 25 dB.

4. Increase the smoothing to its maximum, or near maximum, value by pressing:

   ⇨

5. To turn on the noise source voltage, press:

   ON/OFF

   GPIB: SP20.1ET

   The green NOISE DRIVE indicator will light when the voltage is on.

6. Observe and record the exact voltage readout given in Window A. (For example, 2.9805)

7. To turn off the noise source voltage, press:

   ON/OFF

   GPIB: SP20.0ET

   The green NOISE DRIVE indicator will go out when the voltage is off.

8. Reduce the value of the precision variable attenuator until the voltage displayed in Window A is exactly the same as it was in Step 6. (For example, the attenuator is reduced to 5.35 dB to again obtain a voltage reading of 2.9805.)

9. Compute the difference between the attenuator settings in Step 6 and Step 8. This difference is the Y-Factor in dB. (For example, 15.0 dB minus 5.35 dB. The difference is 9.65 dB and this is the Y-Factor of the DUT.)

3-29. CALIBRATED NOISE SOURCE

The noise source is an accurately calibrated device which, when stimulated by the NOISE DRIVE voltage, continuously generates white, broadband noise over a known frequency range. The noise source output is characterized as a series of ENR (Excess Noise Ratio) values. The calibration data for a given noise source consists of ENR values (expressed in decibels) at discrete frequency points across its band. Figure 3-17 opposite is a graphic example of calibration data for an Eaton 7618E Solid State Noise Source.

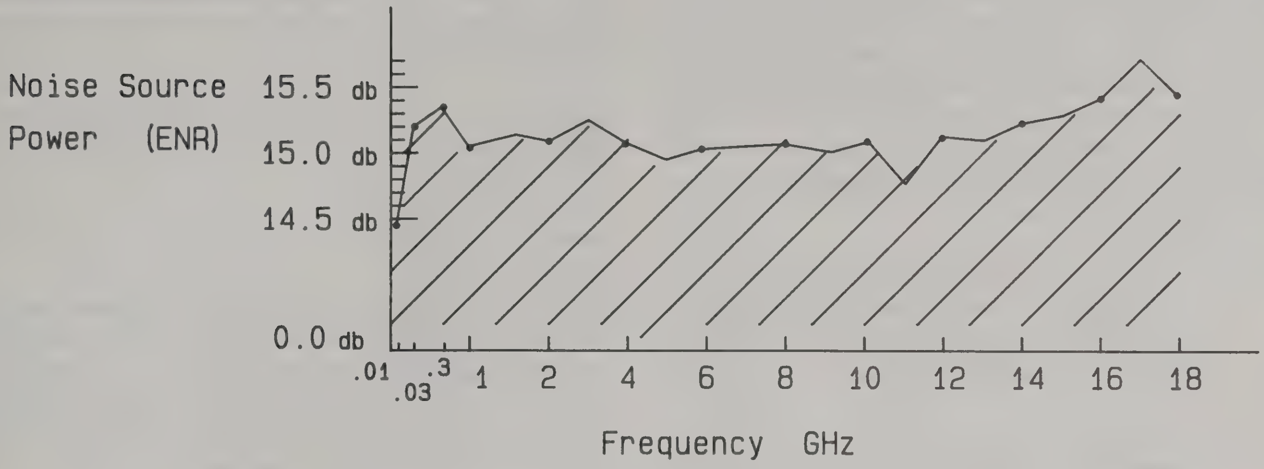


Figure 3-17. EXAMPLE OF CALIBRATED NOISE SOURCE DATA (EATON 7618E CALIBRATED NOISE SOURCE)

These ENR values are inscribed on the calibration label which is affixed to the noise source and are also listed on the calibration data sheet accompanying each Eaton Solid State Noise Generator. The ENR values and their associated frequencies are entered into the ENR Tables of the 2075 by the user before any measurements can be made. Each frequency entry is paired with the ENR value at that frequency. For more information see Paragraphs 3-9 and 3-31.

For especially high frequency applications, a Gas Discharge Noise Generator and a Gas Discharge Noise Generator Power Supply, such as the Eaton 7175, may be used with the 2075. In such a case, a time delay value must be entered. The time delay is always entered in milliseconds and the valid range is from 1 ms to 10 seconds (10,000 ms). To enter the time delay for a gas discharge noise source, for example 75 ms, press:

SPEC FUNC 3.1 ENTER

75 ENTER

To activate the time delay, press:

SPEC FUNC 22.1 ENTER

Generally a time delay of 1 millisecond is sufficient.

3-30. NOISE DRIVE VOLTAGE AND INDICATOR

When measurements are made, the 2075 supplies pulses which turn the noise source on and off. These pulses are supplied via the front and rear panel NOISE DRIVE connectors. The ON voltage level is 28.00 volts DC, ± .05 volts. The OFF level is less than 1.0 volt.

The green indicator located immediately above the NOISE DRIVE connector can be programmed to turn on and off synchronously with the pulses. This feature is typically used when making manual measurements requiring a true hot/cold thermal noise source.

Special Function 21.0 is the default or normal mode for the indicator. When this mode is in effect, the indicator is always off, regardless of the voltage applied to the noise source. To activate the indicator, press:

SPEC FUNC 21.1 ENTER

In this mode the indicator will turn on when the noise drive voltage is on, and turn off when the voltage is off. The GPIB code for this is SP 21.1 ET.

3-31. ENR TABLES

Before making noise measurements, it is necessary to enter noise source calibration data into an ENR table. The 2075 has 4 ENR tables in which ENR values (noise source calibration data) can be stored. An optional fifth table is available in the form of a ROM chip which can be ordered with the noise source. A complete procedure for entering ENR values is given in Paragraph 3-9 on page 3-26.

Table 0	stores only one ENR value which is used for all frequencies. At the factory, a value of 15.5 dB is entered into this table. This value may be changed by the user.
Table 1	stores up to 31 ENR values with 31 associated frequencies. Each ENR value and its associated frequency are stored as a pair.
Table 2	stores up to 31 ENR values with 31 associated frequencies. Each ENR value and its associated frequency are stored as a pair.
Table 3	stores up to 31 ENR values with 31 associated frequencies. Each ENR value and its associated frequency are stored as a pair.
Table 4	This table is an optional ROM chip which can be purchased with a matching noise source. The chip contains permanently stored ENR values and associated frequencies for the noise source.

Tables 1, 2, and 3 can be used to store calibration data for three different noise sources. In each of these tables, frequency and ENR values are stored in pairs. That is, each frequency is stored with the ENR value for that frequency. The valid range for frequency entries is 10 MHz through 65,535 MHz. The maximum allowable ENR entry is 80 dB. However, the effective ENR at the input of the DUT cannot exceed 18 dB. The extra range (the difference between 18 and 80 dB) is to allow for losses between the noise source and the DUT.

ENR values are always entered as dB. ENR values below -9.99 dB will be automatically displayed as a ratio after entry.

Table Selection

A table must be selected before its contents can be viewed, before ENR values can be entered, before a Second Stage Calibration is performed, or before a measurement is made. In other words, before performing any operation which involves an ENR table, a table must first be selected by the user.

Special Function 5 is used to select the table. Table 0 is selected by Special Function 5.0. Tables 1 through 3 are selected by Special Functions 5.1 through 5.3 respectively. The optional ROM chip, Table 4, is selected by Special Function 5.4. To select Table 3, for example, press:

SPEC FUNC 5.3 ENTER

The 2075 always remembers which ENR table was last selected and will automatically select that table after it is switched on. If no table has ever been previously selected, the instrument selects Table 0 by default.

Editing Table Contents

Figure 3-18 shows how the data is organized in Tables 1, 2, or 3. Although only 9 entry pairs are shown, up to 31 can be stored.

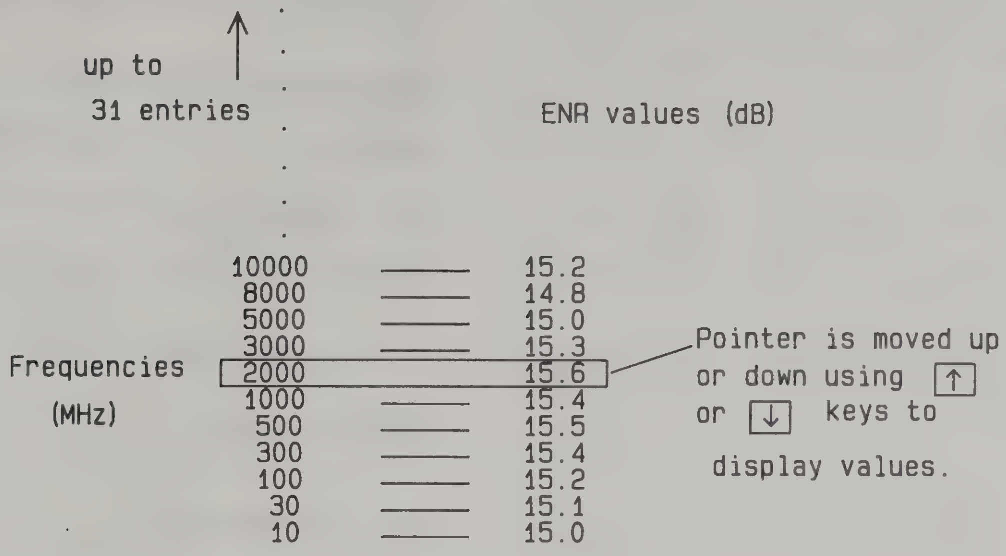


Figure 3-18. ENR TABLE 1, 2 OR 3.

After a table has been selected its contents can easily be examined or edited. To get into the editing mode (this is the same as the data entry mode), press:

ENR

The red light in the **ENR** key will light. The lowest frequency in the table is displayed in Window A and the ENR value for that frequency is displayed in Window B. The ENTER annunciator in Window A begins flashing.

To step through the table and view the data, use the **UP ARROW** and **DOWN ARROW** keys. Each keystroke of the **UP ARROW** key causes the next highest frequency and its ENR value to be displayed. Holding the **UP ARROW** key will cause rapid movement through the table in ascending frequency order. When the highest frequency is reached, the table will wrap around and begin again at the lowest frequency. Pressing or holding the **DOWN ARROW** key causes movement through the table in the opposite direction.

To delete a table entry, first display the entry using the **UP ARROW** or **DOWN ARROW** keys. Then press **CLEAR**. Both the frequency and the ENR value which were displayed are deleted.

The ENTER annunciators in Windows A and B guide the user in making entries.

The ENTER annunciator in Window A blinks to indicate that a frequency may be entered. The ENTER annunciator in Window B blinks to indicate that an ENR value may be entered. After the indicated entry is made, the blinking annunciator automatically shifts to the other window.

The **ENTER** key can be used to toggle the blinking ENTER annunciator back and forth between Windows A and B. For example, if the annunciator is blinking in Window B, but the user desires to enter a new frequency value, pressing the **ENTER** key will cause the annunciator to begin blinking in Window A.

When entering a frequency and ENR value, the frequency must always be entered first. Before entering the frequency the ENTER annunciator must be blinking in Window A.

To enter a frequency (for example, 1000 MHz), press:

1000 ENTER

The frequency, 1000 MHz, will be displayed in Window A and the ENTER annunciator will begin blinking in Window B. To enter the ENR value for 1000 MHz (for example, 15.7 dB), press:

15.7 ENTER

The value 15.7 will be displayed in Window B. Note that the ENTER annunciator now begins to blink in Window A again, indicating that another frequency may now be entered.

To change an existing frequency or ENR value in a table, first use the **UP ARROW** or **DOWN ARROW** keys to display the entry which is to be modified.

To delete both the displayed frequency and the displayed ENR value, press: **CLEAR**. It does not matter whether the ENTER annunciator is blinking in Window A or Window B, both will be deleted.

To change an ENR value, but not the frequency, first make sure that the blinking ENTER annunciator is in Window B. Then press the appropriate numeric keys and then the **ENTER** key to overwrite the old value with the new one. The new ENR value is stored with the displayed frequency.

A frequency cannot be modified. It must be deleted and then a new frequency and ENR value entered.

It is not necessary to enter frequency and ENR values in ascending frequency sequence. The 2075 automatically organizes all entries and stores them in order.

After completing the examination or editing of the table, press the **ENR** key. The red light in the center of the **ENR** key will go off and the instrument exits the ENR mode.

The 2075 accesses the data in the selected ENR table whenever a Second Stage Calibration is performed or when a measurement is taken. The ENR values are used during the calculation of second stage noise figures at each calibration point, and also during calculation of first stage (Device Under Test) noise figure.

During calibration and measurement, the 2075 interpolates ENR values for frequencies between those stored in the table.

GPIB code examples are given:

Table Select:	SP 5.x ET
Enable ENR entry mode:	EN
Entry pairs:	10 MZ 15.5 DB 100 MZ 14.9 DB 300 MZ 15.1 DB etc.
Exit ENR entry mode:	EN

3-32. CALIBRATION

During normal operation of the 2075 two types of calibration are performed by the user. These are Frequency Calibration (FCAL) and Second Stage Calibration. A third calibration, IF Attenuators Calibration, should be performed during normal recalibration procedures if the instrument has been unused for a long period of time, or if a total system reset (Special Function 0.9) has been done. These calibrations are separate and distinct from other procedures covered in the maintenance manual under Alignments and Adjustments. Alignment and adjustment procedures are those typically performed once or twice a year by a calibration facility which then issues a calibration certificate for the instrument.

The following paragraphs cover Frequency Calibration, Second Stage Calibration, and IF Attenuators Calibration.

3-33. FREQUENCY CALIBRATION

Frequency calibration consists of tuning the first local oscillator inside the 2075 to the first IF frequency of 2200 MHz. This automatic procedure ensures the accuracy of the displayed tuned frequency. The message FCAL is displayed on the front panel while this is in progress.

A Frequency Calibration is initiated by any of the following:

1. AC power is applied to the 2075.
2. The **CALIB** key is pressed.
3. The **PRESET** key is pressed.
4. A Total System Reset (Special Function 0.9) is performed.
5. According to the setting of Special Function 15.

Special Function 15 determines when and how often Frequency Calibration will be performed.

Special Function 15.0 is the normal and default Frequency Calibration mode. In this mode, a Frequency Calibration is automatically performed after power-on at intervals of 1 minute, 2 minutes, 4 minutes, and 8 minutes. Thereafter, it is performed every 8 minutes.

Special Function 15.1 causes one Frequency Calibration to be performed immediately. Then Special Function 15 reverts to the mode which was in effect before 15.1 was initiated (15.0 or 15.2).

Special Function 15.2 disables the periodic Frequency Calibration mode set by 15.0. In this mode, Frequency Calibration is not performed periodically nor is it performed when the **CALIB** key is pressed.

To initiate any special function setting (for example, 15.2), press:

SPEC FUNC | 15.2 | ENTER

GPIB: SP 15.2 ET

3-34. SECOND STAGE CALIBRATION

SECOND STAGE CALIBRATION is the measurement of the Noise Figure of the second stage at discrete frequency points across the band. These measurements are taken at up to 100 frequency points for each of three different input gain settings.

The term SECOND STAGE refers to the 2075 and any other equipment which is part of the measurement system, following the Device Under Test. The term FIRST STAGE refers only to the Device Under Test and any components between the noise source and the DUT.

Before any corrected measurement can be made, a Second Stage Calibration must be performed to measure the Noise Figure of the second stage. Then, after the Device Under Test is connected into the system and measured, the effects of second stage noise are subtracted to achieve a highly accurate, corrected, first stage measurement.

External relays can be used to automate the Second Stage Calibration. When the calibration is performed the 2075 applies an actuating voltage to the relays which switch to the calibration path, leaving the DUT out of the circuit. When the calibration is completed, the 2075 removes the voltage from the relays thereby placing the DUT in the circuit. The relay voltage is supplied via the front panel RELAY POWER connector. This voltage can be set to +5, +15, or +30 volts DC using the procedure of Paragraph 2-6. The factory setting is + 30 volts DC. Figure 3-19 illustrates a setup for Test Configuration 2, single sideband, using external relays. When Special Function 10.1 is activated, the relay power will remain on even after the calibration is completed.

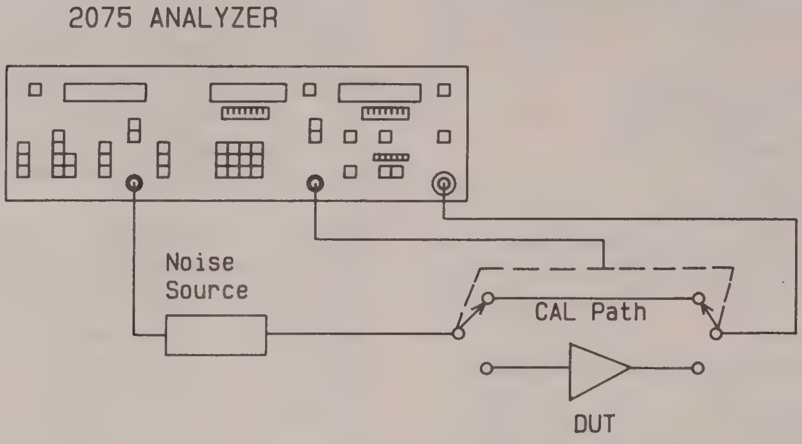


Figure 3-19. SETUP WITH EXTERNAL RELAYS USED TO AUTOMATE CALIBRATION

The start frequency, stop frequency, and step size which are entered as sweep parameters determine the points at which Second Stage Calibration data is taken. In order to obtain accurate corrected measurements, the calibration points must be the same as the measurement points. Second stage calibration can be done at a maximum of 100 points. If a measurement is attempted at an uncalibrated frequency point, error message 110 will be displayed. However, enabling Special Function 24.1 causes the 2075 to interpolate additional calibration points and allows measurement at those frequencies. Such measurements are less accurate.

If calibration is attempted at more than 100 points, calibration table overflow occurs and error message 117 is displayed.

To perform a Second Stage Calibration for swept measurements, press:

CALIB

The 2075 performs a frequency calibration and then the second stage calibration. During this process the front panel successively displays:

FCAL	during the Frequency Calibration (FCAL is not performed if Special Function 15 is set to 15.2)
CAL0	during initialization of the calibration tables
CAL1	during calibration at the first input gain setting (+25 dB)
CAL2	during calibration at the second input gain setting (+10 dB)
CAL3	during calibration at the third input gain setting (−5 dB)

A Second Stage Calibration in progress can be stopped by pressing the **CALIB** key.

Input gain settings are user-selectable. The default settings are +25 dB, +10 dB, and -5 dB. Where an external amplifier is part of the second stage, and its gain is greater than 20 dB, a different set of input gain settings must be selected. For more information on input gain settings see Paragraph 3-35 and Special Function 16.

To perform a single frequency Second Stage Calibration at a fixed frequency, press:

SHIFT CALIB

The 2075 does the FCAL, CAL0, CAL1, CAL2, and CAL3 at the single fixed frequency.

When a calibration is completed, the 2075 automatically goes into the corrected measurement mode, more specifically, the F + G mode.

Calibration data is saved until a new calibration is performed or until AC power is removed from the instrument.

The calibration process disables all front panel keys except for the **CALIB** key which may be pressed to abort a calibration.

In order to save time when a high degree of smoothing is in use, the calibration process can be stopped after CAL1 is completed. This should be done only if this first calibration range is sufficient for the measurement which is to be made. If the calibration is stopped immediately after the CAL 1 range is done, then Range 2 (CAL2) and Range 3 (CAL3) data will not be taken. Therefore, measurements made in those ranges will not be valid.

Likewise, the calibration process can be stopped after completion of the CAL2. In this case no new calibration data is taken for the CAL3 range and, therefore, a measurement requiring CAL3 data would be invalid. After a calibration is stopped prematurely, and the measurement is made, if the calibrated range is insufficient for the measurement, no error message will occur. It is the responsibility of the user to insure that when a calibration is aborted, the ranges which were performed will be sufficient for the measurement to be taken.

3-35. INPUT GAIN SELECTION

During Second Stage Calibration, data is taken at three different input gain settings. The input gain settings are determined by the levels of RF attenuation the 2075 places in its RF amplifier section. The greater the external gain of the second stage, the more attenuation is required.

Where an external amplifier with more than 4 dB of gain is part of the Second Stage, a group of input gain settings must be chosen by the user. The correct input gain settings will prevent the input to the 2075 from exceeding the allowable power range of the Final Detector.

There are three groups of input gain settings available and they are shown below:

ALLOWABLE SECOND STAGE EXTERNAL GAIN	INPUT GAIN SETTING GROUPS	SPECIAL FUNCTION	GPIB CODE
4 dB or less	0, -15, -30 dB	16.1	C0
4 dB to 25 dB	-15, -30, -40 dB	16.2	C1
25 dB to 38 dB	-30, -40, -55 dB	16.3	C2

The first group, 0, -15, and -30 dB, is the normal or default selection.

To select a group(for example, the second group), press:

SPEC FUNC 16.2 ENTER

GPIB: SP16.2ET

Gain Measurement Range

Although the 2075 specifications list the gain range as -20 to +50 dB, this maximum figure is actually a worst case situation which assumes a DUT input bandwidth of 1900 MHz or greater.

The 2075 is actually capable of measuring gains greater than 50 dB depending on the bandwidth of the Device Under Test. For instance, if the DUT bandwidth is reduced to 190 MHz, the 2075 can measure greater than 60 dB of gain. Reducing the bandwidth of the DUT to 19 MHz would further increase the available gain range to 70 dB or greater.

The total gain measurement range of the 2075 can be expressed as a function of bandwidth ratios as follows:

$$\text{Gain Measurement Range} = 10 \text{ Log} \left[\frac{1900}{\text{BW of DUT}} \right] + 50$$

3-36. IF ATTENUATORS CALIBRATION

The IF Attenuators Calibration procedure is included as part of the Performance Verification Procedures covered in Section 5 of this manual. Those procedures should be performed on a new 2075, and again at six month intervals. This paragraph is included here to give additional information on IF Attenuators Calibration.

At approximately six month intervals, the IF attenuators should be calibrated to compensate for minor shifts in the attenuator values. Where the 2075 is subjected to wide variations of ambient temperature, the attenuators should be calibrated more frequently. The IF attenuators must also be calibrated after the 2075 has undergone a total system reset (Special Function 0.9).

During the IF Attenuators Calibration, the 2075 turns off the power to the noise source and measures each of the attenuators in its IF stage, using its own noise power detector. The resulting data is stored in battery backed-up memory and later used to correct gain measurements. This calibration takes only a few seconds. When it is completed, the 2075 reverts to its normal operating mode. This calibration data is erased when a total system reset is performed.

To perform an IF Attenuators Calibration, remove all devices connected to the RF input. Then, to save the present states of the front panel control parameters in front panel storage register 0, press:

PRESET

After the PRESET, press:

SPEC FUNC 19.1 ENTER

During the five steps, the front panel will display the following messages:

CAL0 CAL1 CAL2 CAL3 CAL4

During CAL0, all IF attenuation is removed. During CAL1, the 5 dB IF attenuator is measured. During CAL2, the 10 dB attenuator is measured. During CAL3 the 15 dB attenuator is measured, and during CAL 4, the second 15 dB attenuator is measured. When the CAL4 message disappears, the calibration is completed.

3-37. SELECTION OF SIDEBAND PARAMETERS

When using Test Configurations 2 through 6, external downconversion is performed and a sideband parameter must be selected. Double sideband can be selected only in Test Configurations 2 and 4. Single sideband, either upper or lower, can be selected in Test Configurations 2 through 6.

Speaking generally, double sideband measurements are less accurate than single sideband measurements. However, if the total overall gain of the Device Under Test is 20 dB or greater, inaccuracy of double sideband measurements due to noise in the second sideband is not significant. Also, accuracy of double sideband measurements can be increased by using a low frequency IF so that the two sidebands are closer together in frequency. This reduces the differences in noise level from sideband to sideband, and improves accuracy.

During single sideband measurements, a high-pass, low-pass, or band-pass filter must be used to reject noise at unwanted image frequencies. Otherwise, noise from the image band, as well as noise from the RF measurement band, would be downconverted to the same IF band. Generally, the Device Under Test will have a different response in the RF measurement and image bands, and the actual measurement then becomes an average of the two unequal responses when no filter is used.

For a lower sideband measurement, a low-pass filter is used. For an upper sideband measurement, a high-pass filter is used. Because a low-pass filter rejects all frequencies and harmonics above its cutoff frequency, lower sideband measurements may be preferred to upper sideband. It should be noted that where a single sideband measurement is made and a filter with the needed cutoff frequency is not available, gain compensation can be used to correct for the error due to noise from the unwanted image sideband. (See Paragraph 3-40 on page 3-86.)

The width of the RF measurement range determines if measurements can be made using single or double sideband. As indicated in Table 3-4, Selecting the Test Configuration, measurements taken over an RF range wider than 1.6 GHz must be made double sideband, and Test Configuration 2 or 4 must be used. This 1.6 GHz figure is somewhat arbitrary, but it is based on the practical problem of finding a filter with the correct cutoff frequency when making single sideband measurements. The following discussion will show how this problem affects the choice of test configuration and sideband parameters.

Figure 3-20 is an example of a measurement situation using Test Configuration 3. As shown in Table 3-4, this configuration requires a fixed frequency local oscillator which produces a variable frequency IF. Measurements are made over an RF range less than 1.6 GHz wide, and therefore a single sideband parameter is chosen. In this case, lower single sideband is used.

1. Measurements are desired from 3.7 GHz to 4.2 GHz. The RF range is 500 MHz wide.
2. The local oscillator frequency remains fixed at 5.2 GHz.
3. IF frequencies vary from 1.5 GHz to 1.0 GHz. (5.2 - 3.7 = 1.5 GHz) to (5.2 - 4.2 = 1.0 GHz)
4. Unfiltered image frequencies will fold into the IF frequencies. (6.7 - 5.2 = 1.5 GHz) to (6.2 - 5.2 = 1.0 GHz)
5. To obtain accurate measurements a low-pass filter is used to filter out the image frequencies. The cutoff frequency of the filter must be between 4.2 GHz and 6.2 GHz. It would be relatively easy to find a filter with a cutoff frequency in this range since it is 2000 MHz wide. It should be noted that the filter must not roll-off below 4.2 GHz and it should achieve 40 dB or more of rejection by 6.2 GHz.
6. It is sound engineering practice to also provide isolation between the DUT and the mixer. This prevents mixer products and local oscillator leakage through the mixer from interacting with the DUT. To accomplish this, the low-pass filter cutoff frequency must be between 4.2 GHz and 5.2 GHz, a 1000 MHz range. Thus, it is slightly more difficult to find the right filter.
7. Go to the next example to see how increasing the width of the RF measurement range increases this problem.

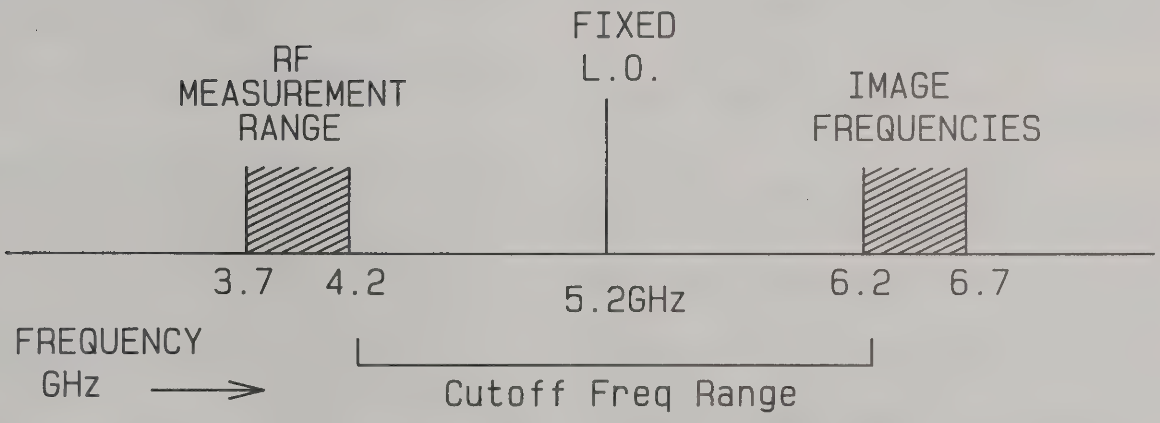


Figure 3-20. EXAMPLE 1 - SIDEBAND SELECTION

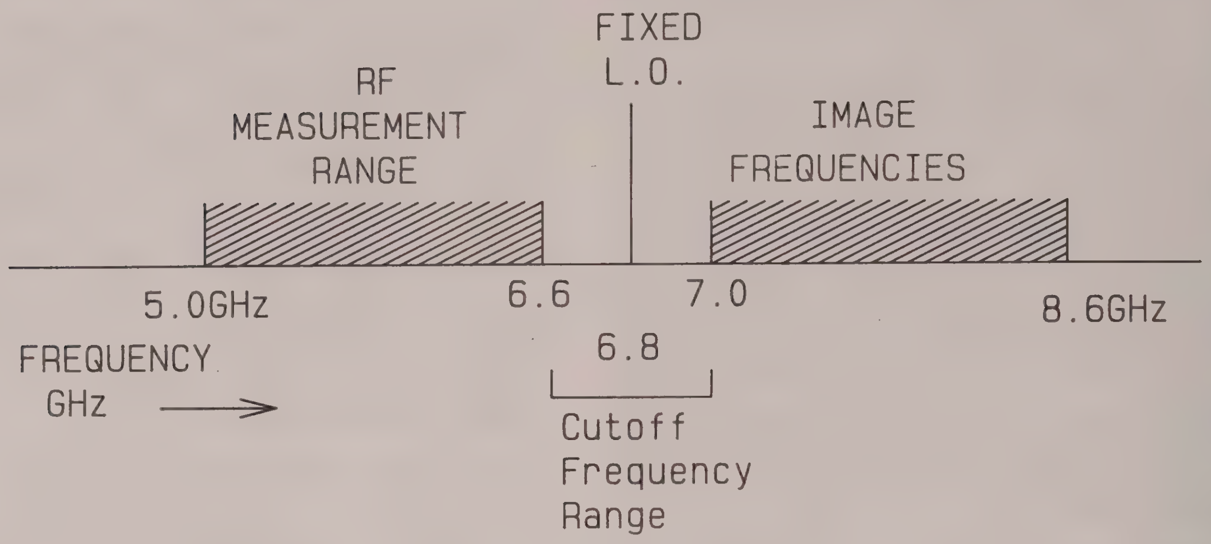


Figure 3-21. EXAMPLE 2 - SIDEBAND SELECTION

Figure 3-21 also shows an example using Test Configuration 3. Again, a fixed frequency local oscillator is used to produce a variable IF. Single lower sideband is used. However, the RF measurement range is expanded to 1.6 GHz width.

1. Measurements are desired from 5.0 GHz to 6.6 GHz. The RF measurement range is 1.6 GHz wide.
2. The local oscillator frequency remains fixed at 6.8 GHz.
3. IF frequencies vary from 1.8 GHz to 0.2 GHz.
   (6.8 - 5.0 = 1.8 GHz) to (6.8 - 6.6 = 0.2 GHz)
4. Unfiltered image frequencies will fold into the IF frequencies.
   (8.6 - 6.8 = 1.8 GHz) to (7.0 - 6.8 = 0.2 GHz)
5. To obtain accurate measurements a low-pass filter is needed to filter out the image frequencies. The cutoff frequency of the filter must be between 6.6 GHz and 7.0 GHz. It is much more difficult to find a filter with a cutoff frequency in this range since it is only 400 MHz wide. The filter must not roll-off below 6.6 GHz and it should achieve 40 dB or more of rejection by 7.0 GHz.
6. If the filter is to provide isolation between the DUT and the mixer, its cutoff frequency must fall between 6.6 MHz and 6.8 MHz. With this allowable range of only 200 MHz, it becomes very difficult to find the right filter.
7. One solution to this problem is to reduce the width of the RF measurement range and make two or more measurement sweeps. Another possibility is to make the measurement in double sideband mode using Test Configuration 2 or 4. A third alternative is to use Gain Compensation to correct for the additional noise from the unwanted sideband. (See Paragraph 3-40.)
8. Go to the next example to see how this problem is slightly different using Test Configuration 2 or 4.

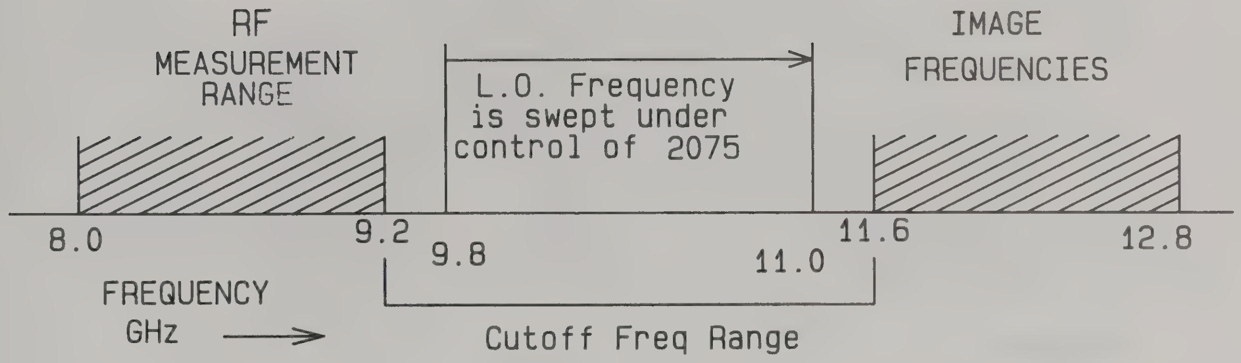


Figure 3-22. EXAMPLE 3 - SIDEBAND SELECTION

Figure 3-22 is an example of a test situation using Test Configuration 2.

As shown in Table 3-4, this configuration requires a variable frequency local oscillator and produces a fixed frequency IF. Measurements are made over an RF range less than 1.6 GHz wide, and therefore a single sideband parameter is chosen. In this case, lower sideband is used.

1. Measurements are desired from 8.0 GHz to 9.2 GHz. The RF range is 1.2 GHz wide.

2. The local oscillator frequency is varied from 9.8 GHz to 11.0 GHz.

3. The IF frequency is fixed at 1.8 GHz.
   (9.8 - 8.0 = 1.8 GHz) to (11.0 - 9.2 = 1.8 GHz)

4. Unfiltered image frequencies will fold into the IF frequencies.
   (11.6 - 9.8 = 1.8 GHz) to (12.8 - 11.0 = 1.8 GHz)

5. To obtain accurate measurements a low-pass filter must be used to filter out the image frequencies. The cutoff frequency of the low-pass filter must be between 9.2 GHz and 11.6 GHz. It is relatively easy to find a filter having a cutoff frequency within this range since it is 2.4 GHz wide. Again, however, to isolate the DUT from mixer products would require that the filter cutoff frequency be between 9.2 and 9.8 GHz, a range of only 600 MHz.

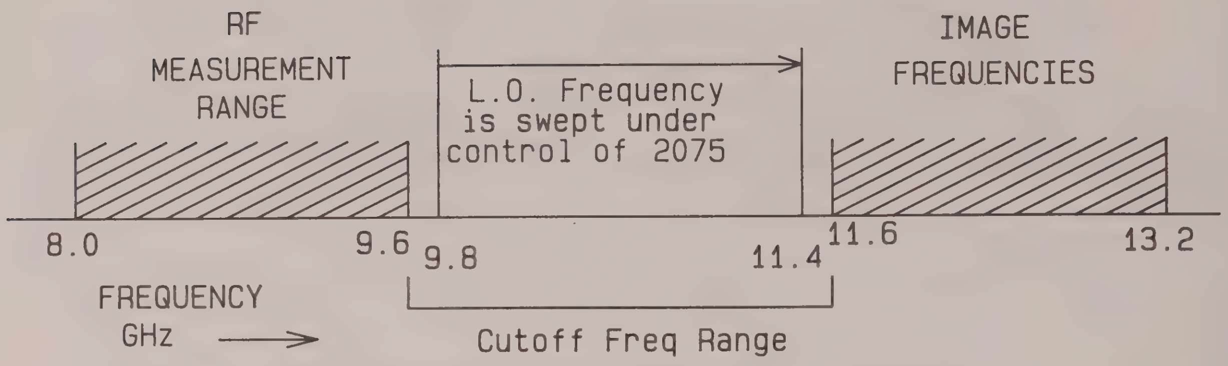


Figure 3-23. EXAMPLE 4 - SIDEBAND SELECTION

Figure 3-23 is an example of a test situation using Test Configuration 2. Again, this configuration requires a variable frequency local oscillator and produces a fixed frequency IF. In the case below, measurements are made over an RF range which is 1.6 GHz wide, and a single sideband parameter is chosen.

1. Measurements are desired from 8.0 GHz to 9.6 GHz. The RF range is 1.6 GHz wide.

2. The local oscillator frequency is varied from 9.8 GHz to 11.4 GHz.

3. The IF frequency is fixed at 1.8 GHz.
   (9.8 - 8.0 = 1.8 GHz) to (11.4 - 9.6 = 1.8 GHz)

4. Unfiltered image frequencies will fold into the IF frequencies.
   (11.6 - 9.8 = 1.8 GHz) to (13.2 - 11.4 = 1.8 GHz)

5. A low-pass filter is used to filter out the image frequencies. The cutoff frequency of the filter must fall between 9.6 and 11.6 GHz, a range of 2000 MHz. If local oscillator leakage and mixer products are to be isolated from the DUT, the filter cutoff frequency would have to fall between 9.6 and 9.8 MHz, a range of only 200 MHz. Thus it can be seen how increasing the RF measurement range increases the difficulty of obtaining a filter with the correct cutoff frequency. One solution to this problem is to decrease the RF measurement range and make several swept measurements. Another solution is to make a double sideband measurement using test configuration 2 or 4. Another solution is to use gain compensation to correct for the additional noise from the unwanted sideband. See Paragraph 3-40.

6. These are only four examples. Depending on the RF frequencies of measurement, the IF frequencies, and the test configuration used, the situation will vary. This is why the 1.6 GHz figure for maximum RF range of single sideband measurements is somewhat arbitrary, but may be useful as a practical limit.

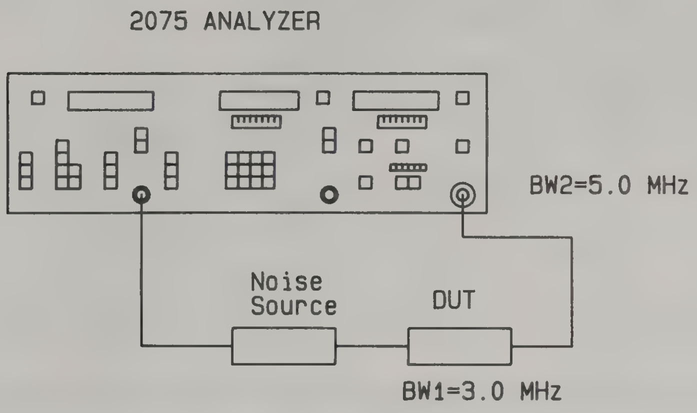


Figure 3-24. BANDWIDTH COMPENSATION - EXAMPLE 1

3-38. BANDWIDTH COMPENSATION

If the noise bandwidth of the Device Under Test (First Stage) is narrower than the noise bandwidth of the Second Stage, bandwidth compensation should be employed to ensure measurement accuracy. However, it should be employed only if the Gain of the Device Under Test is greater than Unity.

The term FIRST STAGE refers only to the Device Under Test. The term SECOND STAGE refers to the 2075 and any other RF devices which are part of the measurement system, excluding the DUT.

If the bandwidth of the DUT is wider than or equal to the bandwidth of the Second Stage, then no bandwidth compensation is needed. In such a case, Special Function 4.0 should be selected. This selects no bandwidth compensation and uses default values of 5.0 MHz for each bandwidth.

The nominal bandwidth of the 2075 is 5.0 MHz and this is usually the bandwidth of the Second Stage. However, where external amplifiers or mixers are used as part of the Second Stage, and one of these has a bandwidth narrower than 5.0 MHz, this narrower bandwidth is the bandwidth of the Second Stage. For example, if an external mixer is used as part of the Second Stage, and its IF bandwidth is 3.1 MHz, the Second Stage bandwidth is considered to be 3.1 MHz.

The examples given illustrate several cases.

In this first example, the BW of the First Stage is 3.0 MHz and the BW of the Second Stage is 5.0 MHz. Employ BW compensation by entering:

SPEC FUNC 4.1 ENTER
3.0 ENTER

SPEC FUNC 4.2 ENTER
5.0 ENTER

SPEC FUNC 4.3 ENTER

(Turns on BW Compensation)

Notice that Special Function 4.1 is used to enter the First Stage BW (BW1) and 4.2 is used to enter the Second Stage BW (BW2). When BW compensation is used, follow the normal procedures as given for the different test configurations, but make the entries before performing Second Stage Calibration.

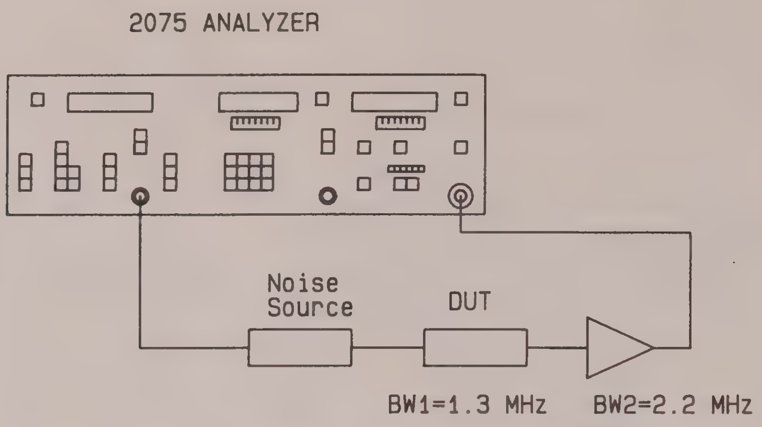


Figure 3-25. BANDWIDTH COMPENSATION - EXAMPLE 2

In this second example the BW of the First Stage (DUT) is 1.3 MHz and the smallest bandwidth of the Second Stage (the amplifier) is 2.2 MHz. Make the entries as follows:

SPEC FUNC 4.1 ENTER

1.3 ENTER

SPEC FUNC 4.2 ENTER

2.2 ENTER

SPEC FUNC 4.3

(To turn on BW compensation)

The GPIB code for Special Function 4.1 is N1.
The GPIB code for Special Function 4.2 is N2.
The GPIB code for Special Function 4.3 is N3.

Because, where BW compensation is required, the accuracy of measurements depends on how accurately BW1 and BW2 are known, the actual bandwidths should be measured before entry into the 2075. If the bandwidth of the DUT is not known, the procedures given in Paragraph 3-39 can be used to determine the ratio of the bandwidths. It is actually more important to know the correct ratio than it is to know the exact value for each.

Where the bandwidth of the DUT is known to be less than 5.0 MHz (the nominal value of the 2075) it is possible to eliminate the need for bandwidth compensation by employing an alternate scheme. This scheme is accomplished by adding a narrow band-pass filter to the Second Stage. The bandwidth of the filter must be less than the bandwidth of the DUT. This makes the First Stage BW wider than the Second Stage BW. It thereby eliminates the need to use BW compensation and eliminates the need to know the precise bandwidths of the two stages. Where this method is used, enter Special Function 4.0 (no bandwidth compensation) and the nominal default values of 5.0 MHz will be used for the first and Second Stage bandwidths.

3-39. DETERMINING THE BANDWIDTH RATIO OF THE FIRST AND SECOND STAGES

When the noise bandwidth of the First Stage is narrower than the noise bandwidth of Second Stage, bandwidth compensation must be employed to improve the accuracy of measurements. (Refer to Paragraph 3-38 on page 3-82.)

For improved accuracy it is actually more important to know the ratio of the First Stage to Second Stage bandwidth than it is to know the precise bandwidth for each. The following procedure shows how to determine this bandwidth ratio when the nominal value of 5.0 MHz is used for the Second Stage BW. It consists of:

A. Measuring the insertion loss or gain of the DUT using a power meter.

B. Measuring the insertion loss or gain of the DUT using the 2075.

C. Calculating the bandwidth ratio.

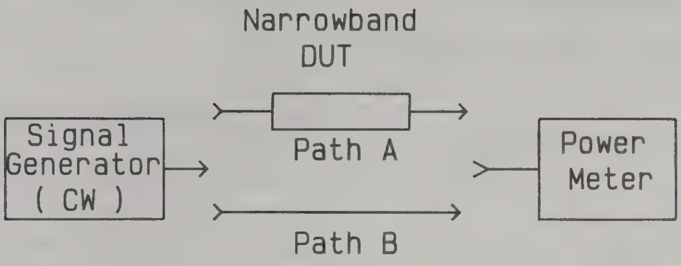


Figure 3-26. INSERTION LOSS MEASUREMENT WITH POWER METER

To measure the insertion loss or gain of the DUT using a power meter perform the following steps:

1. Connect the DUT between the signal generator and the power meter as shown in Path A of Figure 3-26 below.
2. Tune the CW signal generator to obtain a peak reading on the power meter. Record the frequency that gives the peak reading.
3. Adjust the level of the CW signal generator to set a convenient reference level on the power meter. Record this level.
4. Remove the DUT from the setup.
5. Connect the CW signal generator directly to the power meter as shown in Path B of Figure 3-26 above.
6. Note the change in level on the power meter. The amount of increase over that noted in Step 3 is the insertion loss of the DUT. If the power meter reading decreases from that noted in Step 3, the decrease is the insertion gain of the DUT.

To measure the insertion loss or gain of the DUT using the 2075 perform the following steps:

7. Connect the noise source to the input of the 2075 as shown in Path A of Figure 3-27 below.
8. Set the Start and Stop frequencies 4 MHz above and 4 MHz below the frequency recorded in Step 2 above. Use a Step Size of .1 MHz and enter Special Function 9.1 to enable display resolution of .1 MHz.
9. Press the **CALIB** key to perform a Second Stage Calibration. Use sufficient smoothing to produce accurate results.
10. After the calibration is complete, connect the DUT as shown in Path B of Figure 3-27 below.
11. Tune the 2075 to the frequency which produces the highest gain, or the least loss. This will be the same frequency that was recorded in Step 2. Measure the Gain by pressing **F + G**.
12. Record the gain as indicated in Window B of the 2075.

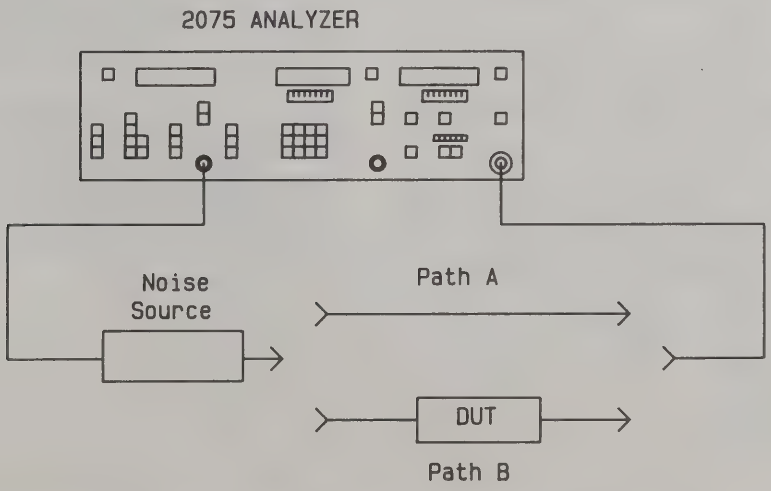


Figure 3-27. INSERTION LOSS MEASUREMENT WITH 2075

To calculate the bandwidth ratio of the First Stage to the Second Stage use the following equations:

GP = Gain or loss measured with the power meter (Step 6)

GN = Gain or loss measured using the 2075 (Step 12)

BL = Bandwidth loss (loss due to bandwidth reduction)

$GN - GP = BL$ and

$10^{\left(\frac{BL}{10}\right)}$ = The bandwidth of the DUT versus the bandwidth of the 2075.

Example 1

$GP = 25$ dB
$GN = 19$ dB (Gain)

$GN - GP = BL$
$19 - 25 = -6$ dB and $10^{\left(\frac{-6}{10}\right)} = .251$

The bandwidth of the DUT is .251 of the 2075 bandwidth.

In Example 1 above, the value for the First Stage bandwidth would be entered as 1.25 MHz (.251 x 5.0MHz). This would be accomplished by pressing:

SPEC FUNC 4.1 ENTER

1.25 ENTER

Example 2

$GP = -3$ dB
$GN = -7$ dB (loss)

$GN - GP = BL$
$-7 - (-3) = -4$ dB and $10^{\left(\frac{-4}{10}\right)} = .398$

The bandwidth of the DUT is .398 of the 2075 bandwidth.

In Example 2 above, the value for the First Stage bandwidth would be entered as 1.99 MHz (.398 x 5.0 MHz). This would be accomplished by pressing:

SPEC FUNC 4.1 ENTER

1.99 ENTER

In both examples, the nominal or default value of 5.0 MHz would be used for the bandwidth of the 2075.

3-40. COMPENSATION FOR LOSS OR GAIN

The 2075 provides a means of compensating for known losses (or gains). Loss 1 is a loss between the noise source and the Device Under Test. Loss 2 is a loss between the Device Under Test and the 2075. Typically such losses are due to test cables or other devices which are part of the First Stage and, therefore, are not in the setup during Second Stage Calibration.

When the values for Loss 1 and Loss 2 are entered, a single temperature for both losses is also entered. Loss 1 and Loss 2 are considered to have the same temperature, which is the ambient temperature of the test area. The temperature can be entered in kelvins, degrees Fahrenheit, or degrees Centigrade. If no values are entered, default values of 296.0 K for the temperature and 0 dB for the losses are assumed. Compensation can be made for only one loss (or gain), instead of two, where desired.

A negative loss equates to a gain. When compensating for a gain instead of a loss, enter a minus (-) sign before the numeric value. Only Loss 1 can be entered as a minus value (gain).

Special Functions 17 and 18 are used to enter the loss compensation parameters. The following table shows the various functions:

DESCRIPTION	SPECIAL FUNCTION	GPIB CODE
No Loss Compensation (OFF)	17.0	NS
Use Loss Compensation (ON)	17.1	L0
Enter Loss 1 (between NS and DUT)	18.1	L1
Enter Temperature For Loss 1 and 2	18.2	L2
Enter Loss 2 (between DUT and 2075)	18.3	L3

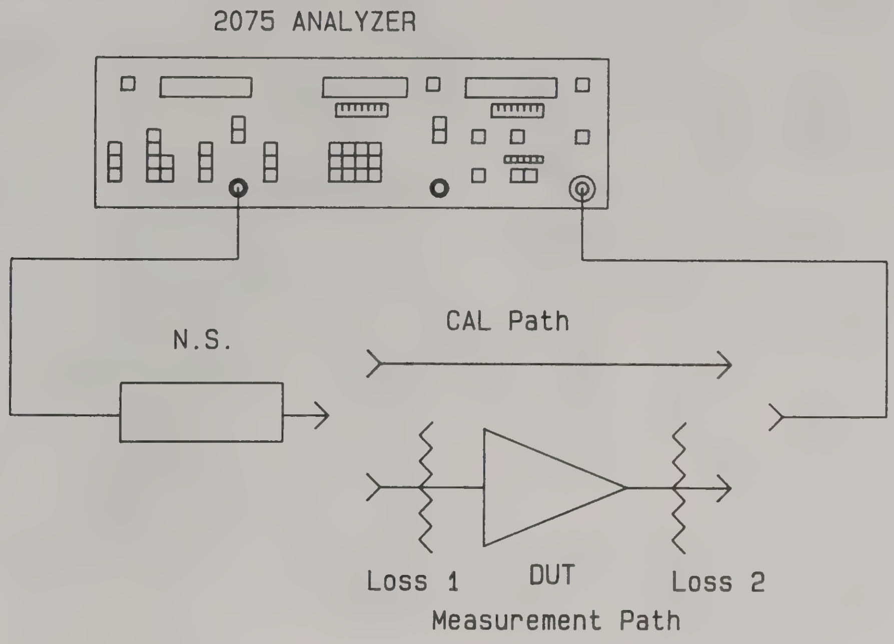


Figure 3-28. LOSS COMPENSATION

After the loss compensation parameters have been entered, all subsequent measurements will use the programmed values. Entering Special Function 17.0 will turn off the loss compensation. However the values of Loss 1, Loss 2, and the temperature, are saved and will be reused when loss compensation is used again by entering Special Function 17.1.

The example above shows the procedure for employing loss compensation.

The Device Under Test is an amplifier which has a loss of 3.03 dB in series with its input (Loss 1) and a loss of 6.11 dB in series with its output (Loss 2). The ambient temperature is 298.0 kelvins.

The measurement procedure does not change from those given in the test configuration procedures of Paragraphs 3-11 through 3-19. The only difference is that the following entries are made before the Second Stage Calibration is performed.

1. To turn on Loss Compensation, press:

SPEC FUNC 17.1 ENTER

2. To enter Loss 1, press:

SPEC FUNC 18.1 ENTER

3.03 ENTER

3. To enter the temperature of the losses, press:

SPEC FUNC 18.2 ENTER

298.0 ENTER

The temperature can be entered as kelvins, degrees Centigrade, or degrees Fahrenheit, using Special Function 12. When set to the default value of 12.0, the entry must be made in kelvins. Special Function 12.1 allows entry in degrees C, and Special Function 12.2 allows entry in degrees F. The 2075 will also convert from one scale to another. Simply make the entry using the correct special function and then change the special function to the scale desired for display. For example, to enter 22 degrees C and then convert to F press:

SPEC FUNC   12.1   ENTER

(set to Centigrade)

SPEC FUNC   18.2   ENTER

22   ENTER

(enter loss temperature)

SPEC FUNC   12.2   ENTER

(set to Fahrenheit)

4. To enter Loss 2 press:

SPEC FUNC   18.3   ENTER

6.11   ENTER

Then proceed normally by performing the Second Stage Calibration. The 2075 automatically turns off loss compensation while performing the Second Stage Calibration and then turns it on again when the calibration is completed.

When loss compensation is no longer desired, turn it off by entering:

SPEC FUNC   17.0   ENTER

Gain compensation is also useful where double sideband measurements are made because a filter with the needed cutoff frequency cannot be obtained for a single sideband measurement. In Test Configuration 4, where the DUT is a mixer, there are no sidebands during Second Stage Calibration because the mixer is not in the setup. That is, the 2075 is using single sideband for the calibration, but makes the measurement using double sideband. In such a case, enter a value of -3 for Loss 1. The 2075 will compensate for the additional unwanted noise power from the unwanted sideband when making the measurement. (This increases accuracy, assuming that the frequency response of the DUT is the same for both sidebands.)

3-41. T_{cold} COMPENSATION

T_{cold} is the OFF temperature of the noise source. It is also the ambient temperature of the test area where the measurements are being made when the noise source is a solid state unit, such as one of the Eaton 76 Series.

The default value of T_{cold} is 296.0 kelvins (23.5 ° C) when the 2075 is PRESET or RESET. When the 2075 is powered-on, T_{cold} is set to whatever previous value has been entered. While this temperature is likely to be close to the actual room temperature, accuracy can be increased by measuring and then entering the actual ambient temperature.

The level of measurement error increases as the actual value of T_{cold} deviates from 296.0 kelvins, and as the value of Noise Figure is reduced.

The following graph shows the increase in error as the actual value of T_{cold} deviates from 290 kelvins. (The graph assumes a stored value of 290 kelvins and a noise source ENR of about 15.3 dB.)

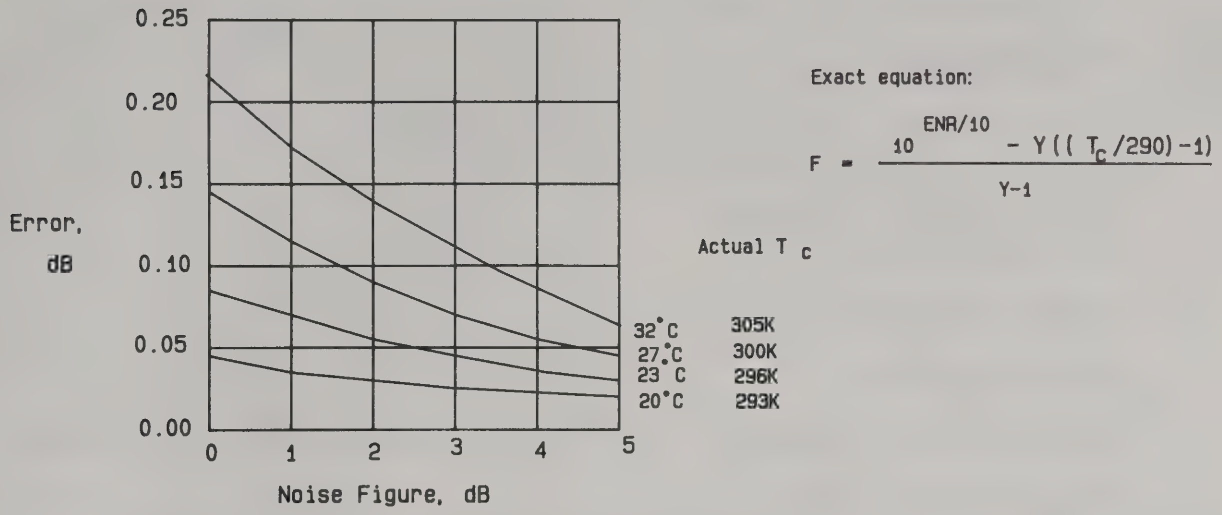


Figure 3-29. ERROR CAUSED BY T_{COLD} DEVIATION FROM 290 K

To enter the true value of T_{cold}, for example 294.0 kelvins, press:

SHIFT ON/OFF 294.0 ENTER

The value for T_{cold} can be entered in units of kelvins, degrees C or degrees F by selecting the correct setting of Special Function 12.

Special Function 12.0 allows entry in kelvins. This is the default state.
Special Function 12.1 allows entry in degrees Centigrade.
Special Function 12.2 allows entry in degrees Fahrenheit.

Simply set Special Function 12 to the appropriate value before making the temperature entry.

The GPIB code for T_{cold} is TC.

In the above graph, the degree of error is derived for the following equations:

The inexact equation is $F = \dfrac{\dfrac{Th - 290\ K}{290\ K}}{Y - 1}$

The exact equation is $F = \dfrac{\left[\dfrac{Th - 290\ K}{290\ K}\right] - Y\left[\dfrac{Tc}{290\ K} - 1\right]}{Y - 1}$

3-42. OSCILLOSCOPES AND RECORDERS TO DISPLAY DATA

The 2075 can output measurement data for display on an oscilloscope, an X-Y plotter, or a strip chart recorder. The setup procedures are similar for all three. Data can be output to only one device at a time.

Any noise-type measurement which the 2075 can make, or any gain measurement, can be displayed on any of these output devices. The units of display at the output device will be the same as those selected for display on the 2075 front panel.

Special Function 7 is used to select the type of device to display the data, as well as the type of display. Table 3-6 shows the different display functions available under Special Function 7.

Table 3-6. Output Display Special Functions

DISPLAY DEVICE	DATA DISPLAYED	SPECIAL FUNCTION	GPIB CODE
SCOPE			
	Display Noise Data and Gain vs. Frequency (for F+G measurements) or Display Noise Data vs. Frequency (for F measurements)	7.0	NP
	Display Test Pattern #1	7.1	P1
	Display Test Pattern #2	7.2	P2
	Display Noise Data vs. Frequency	7.3	NQ
	Display Gain vs. Frequency	7.4	AQ
PLOTTER			
	Position Pen at Lower Left	7.5	LL
	Position Pen at Upper Right	7.6	UR
	Plot Noise Data vs. Frequency	7.7	FQ
	Plot Gain vs. Frequency	7.8	GQ
STRIP CHART			
	Noise Data from X Output and Gain from Y Output	7.9	FG

When the 2075 is powered-up or RESET, Special Function 7 is set to 7.2. When a sweep is started, the instrument changes to Special Function 7.0 unless some other state of Special Function 7 has been selected.

The procedure for setting up the 2075 to output data for display is quite simple. It consists of entering upper and lower limits for Noise Figure and Gain, connecting the display device, and adjusting its controls.

The **LOWER LIMIT** and **UPPER LIMIT** keys are used to enter the limits for noise and gain measurements. The non-shifted mode is used for entering noise measurement limits and the shifted function is used for setting Gain limits. The allowable range for noise measurements is -30 through 9999. The allowable range for Gain is -30.0 through 80.0. After these limits are entered the 2075 will scale the display output accordingly and fit the measurement data on that scale.

The following three example procedures are given for setting up an oscilloscope, an X-Y plotter, and a strip chart recorder.

Output to an Oscilloscope

1. Connect the X-AXIS, Y-AXIS, and Z-AXIS rear panel outputs of the 2075 to the A, B, and Z (horizontal, vertical, and Z) inputs of the oscilloscope. Use DC coupling for the oscilloscope inputs. The oscilloscope should use a positive-going TTL level voltage for blanking from the Z input.

2. Press:

SPEC FUNC **7.2** **ENTER**

This will cause the 2075 to output test pattern #2 (shown below) to the oscilloscope. Adjust the scope input sensitivity controls so that the test pattern just touches the screen edges on all four sides. The top and bottom edges should overlay the top and bottom scalar lines on the scope screen so that vertical scaling will be accurate. Verify that the pattern's diagonal lines cross near the center of the screen. Adjust the INT (Intensity) control on the rear panel of the 2075 to obtain a perceptible difference in intensity between the two halves of the test pattern.

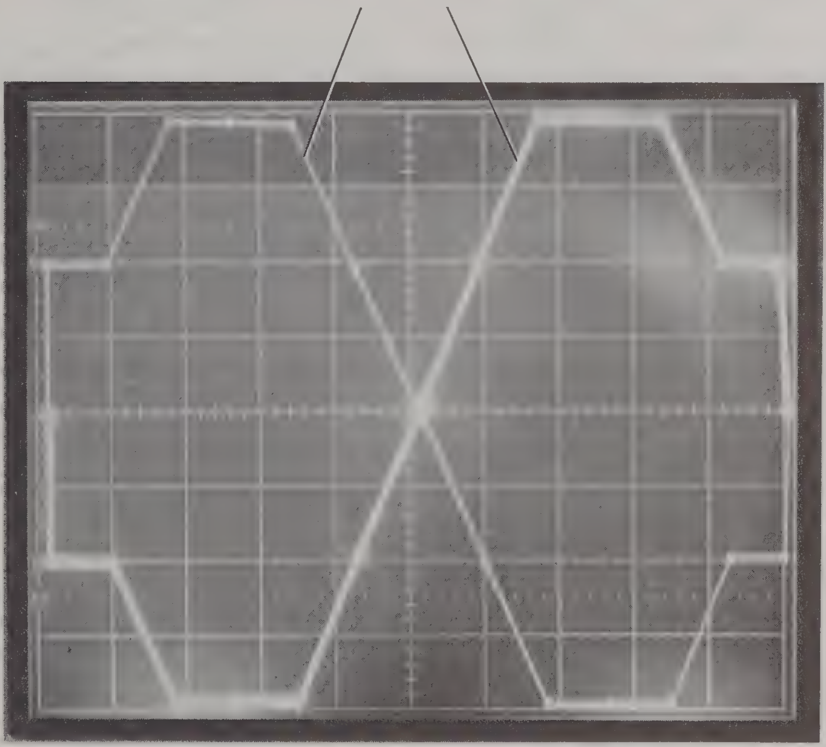

Adjust the INTENSITY Control on the 2075 rear panel to obtain a perceptible difference in intensity between the two halves of the pattern.

Figure 3-30. TEST PATTERN 2 OSCILLOSCOPE DISPLAY

3. Enter the noise measurement lower limit (in this example, 0 dB) by pressing:

   LOWER LIMIT 0 ENTER

   When the first key is pressed, the current programmed value is displayed in Window C.

4. Enter the noise measurement upper limit (in this example, 6 dB) by pressing:

   UPPER LIMIT 6 ENTER

5. Enter the Gain lower limit (in this example, 0 dB) by pressing:

   SHIFT LOWER LIMIT 0 ENTER

6. Enter the Gain upper limit (in this example, 40 dB) by pressing:

   SHIFT UPPER LIMIT 40 ENTER

7. Make the measurement by pressing **SWEEP**. The data will be displayed on the oscillscope as the 2075 makes continuous automatic sweeps.

The figure below is a typical oscilloscope display using Special Function 7.0. Notice that one trace is fainter than the other. When Noise Figure and Gain are displayed simultaneously, the Noise Figure trace is more intense.

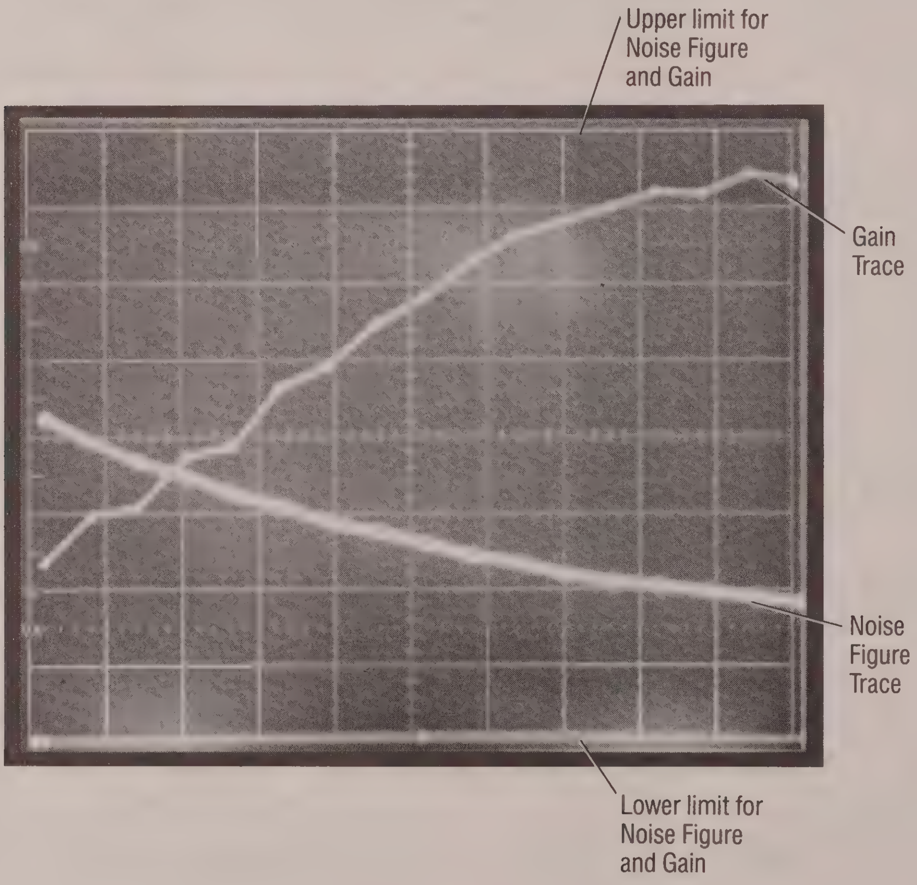

Upper limit for Noise Figure and Gain
Gain Trace
Noise Figure Trace
Lower limit for Noise Figure and Gain

Figure 3-31. NOISE FIGURE AND GAIN OSCILLOSCOPE DISPLAY

The upper and lower limits in the diagram apply to both the noise measurement and the gain measurements respectively.

As the noise measurement is stepped through the selected frequency range, the oscilloscope will emphasize the current frequency point by increasing the intensity of the corresponding dot on the CRT. This allows the observer to keep track of the measurement frequency by correlating the CRT trace with the frequency displayed on the 2075 front panel. The maximum number of dots which can be output to the scope is 256. When a swept measurement is made using more than 255 frequency steps, the 2075 automatically compresses the data to fit the space on the scope display and each dot may represent more than one data point.

When a swept measurement is made using less than 255 frequency steps, the number of segments on the scope display will be equal to the number of frequency steps.

If the step size is such that there is not an integral number of steps from the start to the stop frequency, the last frequency step will be fractional. For example, when sweeping from 400 MHz to 600 MHz, with a step size of 30 MHz, the last frequency step would be 20 MHz (580 to 600 MHz). In such a case, this last frequency step will be displayed as a full segment on the oscilloscope.

Output to an X-Y Plotter

When measurement data is output to an X-Y plotter, swept measurements must be made using 256 frequency steps or less. Otherwise, the 2075 will not output the data.

1. Connect the X-AXIS, Y-AXIS, and Z-AXIS outputs on the rear panel to the X, Y, and pen-lift inputs of the X-Y plotter. Use DC mode for the X and Y inputs. Make certain, however, that the pen-lift input is TTL compatible (0 - 5 volt input).

2. Enter the noise measurement lower limit (in this example, 0 dB) by pressing:

   LOWER LIMIT 0 ENTER

   When the first key is pressed, the current programmed value is displayed in Window C.

3. Enter the noise measurement upper limit (in this example, 6 dB) by pressing:

   UPPER LIMIT 6 ENTER

4. Enter the Gain lower limit (in this example, 0 dB) by pressing:

   SHIFT LOWER LIMIT 0 ENTER

5. Enter the Gain upper limit (in this example, 40 dB) by pressing:

   SHIFT UPPER LIMIT 40 ENTER

6. Press:

   SPEC FUNC 7.5 ENTER

   The 2075 will output the lower left alignment point to the plotter. Adjust the plotter sensitivity controls to position the pen on the lower left corner of the paper.

7. Press:

   SPEC FUNC 7.6 ENTER

   The 2075 will output the upper right alignment point to the plotter. Adjust the plotter sensitivity controls to position the pen on the upper right corner of the paper.

8. Repeat and recheck Steps 6 and 7 as necessary.

9. Choose the measurement to be displayed. Press:

   SPEC FUNC 7.7 ENTER

   to plot noise data versus frequency, OR

Press:

`SPEC FUNC` `7.8` `ENTER`

to plot Gain versus frequency.

Both of these can be plotted on the same chart by plotting one first and then selecting the other and plotting it. The pen color should be changed between plots.

10. To make the measurement and plot the trace, press:

    `SHIFT` `SWEEP`

    The 2075 will execute a single sweep and plot a single trace. It should be noted that if an attempt is made to initiate continuous automatic sweeps, by pressing only **SWEEP** the 2075 will sweep but not plot.

Output to a Strip Chart Recorder

1. Connect the 2075 X-AXIS and Y-AXIS outputs to the Channel 1 and Channel 2 inputs on the strip chart recorder. Noise measurements will be output on the X-AXIS and Gain will be output on the Y-AXIS.

2. Enter the noise measurement lower limit (in this example, 0 dB) by pressing:

   `LOWER LIMIT` `0` `ENTER`

   When the first key is pressed, the current programmed value is displayed in Window C.

3. Enter the noise measurement upper limit (in this example, 6 dB) by pressing:

   `UPPER LIMIT` `6` `ENTER`

4. Enter the Gain lower limit (in this example, 0 dB) by pressing:

   `SHIFT` `LOWER LIMIT` `0` `ENTER`

5. Enter the Gain upper limit (in this example, 40 dB) by pressing:

   `SHIFT` `UPPER LIMIT` `40` `ENTER`

6. Press:

   `SPEC FUNC` `7.5` `ENTER`

   The 2075 will output the lower limit alignment point to both channels. Adjust the sensitivity controls on both channels of the strip chart recorder to position the pens at the bottoms of the charts.

7. Press:

   `SPEC FUNC` `7.6` `ENTER`

   The 2075 will output the upper limit alignment point to both channels. Adjust the sensitivity controls on both channels to position the pens at the tops of the charts.

8. Repeat and recheck Steps 6 and 7 as necessary.

9. Press:

   `SPEC FUNC` `7.9` `ENTER`

   This selects output to a strip chart recorder. Noise measurements will be plotted on Channel 1 (X-AXIS output) and Gain will be plotted on Channel 2 (Y-AXIS output).

10. Where Fixed Frequency measurements are made, the strip chart recorder will plot the readings versus time.

11. It is possible to plot swept measurements also. These are made against frequency, however, the frequency is plotted as time on the strip chart. It should be noted that the 2075 does not always take the same amount of time for each measurement at each frequency step. Therefore, it is not possible to correlate frequency with time.

12. Press the appropriate key on the 2075 to make the measurement.

3-43. SELECTING AN EXTERNAL LOCAL OSCILLATOR

In Test Configurations 2 through 6 the user must supply an external local oscillator for use in downconverting the DUT frequencies to frequencies within the input range of the 2075 (unless the DUT is a receiver with a built-in local oscillator and an IF lower than 1850 MHz). Care must be exercised when selecting an external local oscillator. A suitable signal generator must have the following characteristics:

1. Sufficient output power to drive the mixer into efficient operation.

2. The appropriate frequency range needed for downconversion to the allowable 2075 input frequency range.

3. Good frequency accuracy and repeatability. The degree of accuracy required depends on the measurement. For example, for a noise measurement made at the band edge of an amplifier that has steep skirts, a 5 MHz frequency error may be significant. Some generators can be locked to an external frequency counter to improve accuracy.

4. Low noise ouput, i.e. low phase noise and low floor noise with very low spurious output. Special care must be taken concerning this point. Heterodyne signal generators may be unsuitable. Some so-called synthesizing signal generators switch to a heterodyning process below 2.0 or 2.5 GHz.

   Cavity stabilized klystrons produce the cleanest signals but are cumbersome and are not GPIB programmable. Direct synthesizers are not desirable because of their relatively high floor noise. Indirect synthesizers, such as the Eaton 5440, are good. Ultimately, the only way to be certain that a device is a suitable external local oscillator is to try it.

5. GPIB compatibility where required. (Test Configurations 3 and 5 do not require a GPIB compatible local oscillator.)

3-44. CONTROLLING EXTERNAL LOCAL OSCILLATORS

In the LIMITED CONTROLLER mode, the 2075 can control an external sweep generator which is used as an external local oscillator in Test Configurations 2 through 6. Control programs for three commonly available sweep generators are stored in ROM memory. Table 3-7 below lists these devices and shows the special function which selects the control program for each one. The 2075 also allows the user to write a custom control program for a sweep generator other than those shown.

Table 3-7. Control Programs for External Local Oscillator

EXTERNAL LOCAL OSCILLATOR	SPECIAL FUNCTION
Hewlett Packard 8672	47.0
Wiltron 6600	47.1
Not used	47.2
Hewlett Packard 8350A	47.3
Custom Program	47.4

To select the control program for a Wiltron 6600, press:

SPEC FUNC 47.1 ENTER

The procedures for writing a custom program are presented in the next paragraph.

3-45. WRITING A CUSTOM PROGRAM FOR CONTROLLING A LOCAL OSCILLATOR

The 2075 allows the user to write a custom program for controlling an external local oscillator. The custom program is written into a 40 byte scratch pad in the instrument's RAM.

Instructions are entered in numeric form using the numeric keypad. Each instruction code is entered as the decimal numeric code equivalent for the desired ASCII character. The instructions are entered one byte at a time. As each byte is entered, its decimal form is displayed in Window A on the front panel.

The ASCII characters and their equivalent decimal forms are given in Table 3-8, US ASCII Character Codes. This table is located at the end of this subsection.

The general procedure for writing and executing a control program is shown below. Following that is a detailed sample procedure showing how to write and execute a control program for a Hewlett Packard 8673.

The general procedure is as follows:

1. Enter Special Function 48.1 to activate the user defined control program entry mode.
2. Enter the FREQUENCY PREFIX for the sweep generator by entering the decimal equivalents for the required ASCII characters.
3. Enter the ASCII character ACK (CNTRL-F) by entering the decimal equivalent for that ASCII character. (The decimal equivalent is 6.) When the program executes, the 2075 will insert the appropriate frequency, in MHz, in this location. [The ASCII character BEL (CNTRL-G) can be used to allow insertion of GHz instead of MHz.]
4. Enter the FREQUENCY TERMINATOR for the sweep generator by entering the decimal equivalents for the required ASCII characters.
5. Enter the OUTPUT POWER PREFIX for the sweep generator by entering the decimal equivalents for the required ASCII characters.
6. Enter the ASCII character SOH (CNTRL-A) by entering the decimal equivalent for that ASCII character. (The decimal equivalent is 1.) When the program executes, the 2075 will insert the output power level in this location.
7. Enter the OUTPUT POWER TERMINATOR for the sweep generator by entering the decimal equivalents for the required ASCII characters.
8. Enter the ASCII characters that disable all modulation and marker functions for that sweep generator by entering the decimal equivalents for those ASCII characters.
9. Enter the ASCII code to turn on the RF.
10. Terminate the program entry sequence.
11. Select the custom program as the desired controlling program.
12. Place the 2075 in the GPIB LIMITED CONTROLLER mode.

The following is a sample procedure illustrating the creation and execution of a custom program for controlling a Hewlett Packard 8673.

1. Activate the user defined control program entry mode by pressing:

   SPEC FUNC　48.1　ENTER

2. To enter the frequency prefix (FR), press:

   70　ENTER

   (this enters the ASCII F)

   82　ENTER

   (this enters the ASCII R)

3. To enter the ASCII character ACK (or CNTRL-F) press:

   6 ENTER

4. To enter the frequency terminator (MZ) press:

   77 ENTER

   (this enters the ASCII M)

   90 ENTER

   (this enters the ASCII Z)

5. To enter the output power level prefix (PL) press:

   80 ENTER

   (this enters the ASCII P)

   76 ENTER

   (this enters the ASCII L)

6. To enter the ASCII character SOH (or CNTRL-A) press:

   1 ENTER

7. To enter the output power level terminator (DM) press:

   68 ENTER

   (this enters the ASCII D)

   77 ENTER

   (this enters the ASCII M)

8. To enter the codes that disable amplitude modulation (AO) press:

   65 ENTER

   (this enters the ASCII A)

   79 ENTER

   (this enters the ASCII O)

9. To enter the codes that disable frequency modulation (DO) press:

   68 ENTER

   (this enters the ASCII D)

   79 ENTER

   (this enters the ASCII O)

10. To enter the codes that disable pulse modulation (PO) press:

    80 ENTER

    (this enters the ASCII P)

    79 ENTER

    (this enters the ASCII O)

11. To enter the codes that disable frequency markers (MO) press:

    77 ENTER

    (this enters the ASCII M)

    79 ENTER

    (this enters the ASCII O)

12. To enter the code that turns on the RF output (R1) press:

    82 ENTER

    (this enters the ASCII R)

    49 ENTER

    (this enters the ASCII 1)

13. To terminate the entry sequence press:

    ENTER

14. To select the custom program as the control program press:

    SPEC FUNC 47.4 ENTER

15. To put the the 2075 in the LIMITED CONTROLLER mode press:

    SPEC FUNC 40.2 ENTER

This concludes the procedure.

ASCII Char.	EQUIVALENT FORMS				GPIB
	Dec	Binary	Oct	Hex	
@	64	01000000	100	40	TA0
A	65	01000001	101	41	TA1
B	66	01000010	102	42	TA2
C	67	01000011	103	43	TA3
D	68	01000100	104	44	TA4
E	69	01000101	105	45	TA5
F	70	01000110	106	46	TA6
G	71	01000111	107	47	TA7
H	72	01001000	110	48	TA8
I	73	01001001	111	49	TA9
J	74	01001010	112	4A	TA10
K	75	01001011	113	4B	TA11
L	76	01001100	114	4C	TA12
M	77	01001101	115	4D	TA13
N	78	01001110	116	4E	TA14
O	79	01001111	117	4F	TA15
P	80	01010000	120	50	TA16
Q	81	01010001	121	51	TA17
R	82	01010010	122	52	TA18
S	83	01010011	123	53	TA19
T	84	01010100	124	54	TA20
U	85	01010101	125	55	TA21
V	86	01010110	126	56	TA22
W	87	01010111	127	57	TA23
X	88	01011000	130	58	TA24
Y	89	01011001	131	59	TA25
Z	90	01011010	132	5A	TA26
[	91	01011011	133	5B	TA27
\	92	01011100	134	5C	TA28
]	93	01011101	135	5D	TA29
^	94	01011110	136	5E	TA30
_	95	01011111	137	5F	UNT

ASCII Char.	EQUIVALENT FORMS				GPIB
	Dec	Binary	Oct	Hex	
`	96	01100000	140	60	SC0
a	97	01100001	141	61	SC1
b	98	01100010	142	62	SC2
c	99	01100011	143	63	SC3
d	100	01100100	144	64	SC4
e	101	01100101	145	65	SC5
f	102	01100110	146	66	SC6
g	103	01100111	147	67	SC7
h	104	01101000	150	68	SC8
i	105	01101001	151	69	SC9
j	106	01101010	152	6A	SC10
k	107	01101011	153	6B	SC11
l	108	01101100	154	6C	SC12
m	109	01101101	155	6D	SC13
n	110	01101110	156	6E	SC14
o	111	01101111	157	6F	SC15
p	112	01110000	160	70	SC16
q	113	01110001	161	71	SC17
r	114	01110010	162	72	SC18
s	115	01110011	163	73	SC19
t	116	01110100	164	74	SC20
u	117	01110101	165	75	SC21
v	118	01110110	166	76	SC22
w	119	01110111	167	77	SC23
x	120	01111000	170	78	SC24
y	121	01111001	171	79	SC25
z	122	01111010	172	7A	SC26
{	123	01111011	173	7B	SC27
|	124	01111100	174	7C	SC28
}	125	01111101	175	7D	SC29
~	126	01111110	176	7E	SC30
DEL	127	01111111	177	7F	SC31

Table 3-8. US ASCII Character Codes

ASCII Char.	EQUIVALENT FORMS				GPIB
	Dec	Binary	Oct	Hex	
NUL	0	00000000	000	00	
SOH	1	00000001	001	01	GTL
STX	2	00000010	002	02	
ETX	3	00000011	003	03	
EOT	4	00000100	004	04	SDC
ENQ	5	00000101	005	05	PPC
ACK	6	00000110	006	06	
BEL	7	00000111	007	07	
BS	8	00001000	010	08	GET
HT	9	00001001	011	09	TCT
LF	10	00001010	012	0A	
VT	11	00001011	013	0B	
FF	12	00001100	014	0C	
CR	13	00001101	015	0D	
SO	14	00001110	016	0E	
SI	15	00001111	017	0F	
DLE	16	00010000	020	10	
DC1	17	00010001	021	11	LLO
DC2	18	00010010	022	12	
DC3	19	00010011	023	13	
DC4	20	00010100	024	14	DCL
NAK	21	00010101	025	15	PPU
SYNC	22	00010110	026	16	
ETB	23	00010111	027	17	
CAN	24	00011000	030	18	SPE
EM	25	00011001	031	19	SPD
SUB	26	00011010	032	1A	
ESC	27	00011011	033	1B	
FS	28	00011100	034	1C	
GS	29	00011101	035	1D	
RS	30	00011110	036	1E	
US	31	00011111	037	1F	

ASCII Char.	EQUIVALENT FORMS				GPIB
	Dec	Binary	Oct	Hex	
space	32	00100000	040	20	LA0
!	33	00100001	041	21	LA1
"	34	00100010	042	22	LA2
#	35	00100011	043	23	LA3
$	36	00100100	044	24	LA4
%	37	00100101	045	25	LA5
&	38	00100110	046	26	LA6
'	39	00100111	047	27	LA7
(	40	00101000	050	28	LA8
)	41	00101001	051	29	LA9
*	42	00101010	052	2A	LA10
+	43	00101011	053	2B	LA11
,	44	00101100	054	2C	LA12
–	45	00101101	055	2D	LA13
.	46	00101110	056	2E	LA14
/	47	00101111	057	2F	LA15
0	48	00110000	060	30	LA16
1	49	00110001	061	31	LA17
2	50	00110010	062	32	LA18
3	51	00110011	063	33	LA19
4	52	00110100	064	34	LA20
5	53	00110101	065	35	LA21
6	54	00110110	066	36	LA22
7	55	00110111	067	37	LA23
8	56	00111000	070	38	LA24
9	57	00111001	071	39	LA25
:	58	00111010	072	3A	LA26
;	59	00111011	073	3B	LA27
<	60	00111100	074	3C	LA28
=	61	00111101	075	3D	LA29
>	62	00111110	076	3E	LA30
?	63	00111111	077	3F	UNL

Table 3-8. US ASCII Character Codes (Continued)

3-46. SPECIAL FUNCTIONS

Special Functions extend the range of the instrument's available functions beyond those normally selectable by dedicated front panel keys. Special Functions are selected by entering numeric special function codes using the front panel numeric keypad.

For example, to select Special Function 2.1 press:

SPEC FUNC 2.1 ENTER

This will set Special Function 2 to 2.1 regardless of its previous state.

For each special function code, the integer value to the left of the decimal selects the special function itself, and the number to the right of the decimal selects the state to which that special function will be set.

Each special function has a basic state which is denoted by a 0 to the right of the decimal. For example, the basic states for Special Functions 2 and 3 are 2.0 and 3.0. The only exceptions to this rule are Special Functions 1 and 16 which have no .0 states. For these two, the basic states are denoted by 1.1 and 16.1 respectively.

The non-basic states are indicated by a number other than 0 to the right of the decimal. For example, 2.1 and 2.2 are non-basic states for Special Function 2.

When the 2075 is powered-on, some special functions assume the basic state and some assume the last state they were in before the instrument was powered-off. For a listing of power-on states see Table 3-3. However, after a PRESET or a Total System Reset is performed, most special functions assume their basic states. Refer to Table 3-3 or 3-9.

Some special functions can be stored along with front panel control parameters in the Front Panel Storage Registers. These storable special functions are indicated in Table 3-3.

The current state for each special function is stored in a Special Functions Table in the 2075. To call up this table for examination, press:

SPEC FUNC

Then use the **UP ARROW** and **DOWN ARROW** keys to move up and down through the table to view the current state of each special function. To exit the Table Viewing Mode press the **SPEC FUNC** key again or complete the keystroke sequence for making a special function entry, *numeric keys* and then **ENTER**. Note that only one special function may be changed or entered while in the viewing mode, and this causes an exit from the mode.

The easiest way to edit the table is to enter the viewing mode and note any changes which are desired. Then simply enter the new special functions.

Table 3-9 lists all special functions, their numeric codes, and the corresponding GPIB codes. The table also shows which special functions revert to their basic states upon power-on and which ones assume their previous states. Special functions which are storable in the Front Panel Storage Registers are also indicated.

For any 2075 with Software Update (SU-6), all special function codes can be sent to the 2075 over the GPIB. The GPIB code for special function is SP. The GPIB code and format to send any special function over the bus is:

SP XX.X ET

Insert the appropriate numeric code for the special function in place of the X's. For example, to set Special Function 14.1 over the bus the code would be SP 14.1 ET. The ET is the terminator (GPIB code for ENTER).

Some special functions also have an alphanumeric code (device message code) which can be sent over the GPIB. These special functions can be sent by using the format above, or by sending the alphanumeric character code. For example, Special Function 15.1 can be sent over the GPIB as:

SP 15.1 ET

Or it can be sent as:

FC CR LF

FC is the alphanumeric code, or device message code, for Special Function 15.1. The CR LF is a carriage return, line feed, and is the general line terminator when sending device messages to the 2075. See Paragraph 4-9 for more information on device messages.

Table 3-9. Special Functions Table

Function Type	SF Code	Power Up	S/R	GPIB Code	Function Description
Total System Reset	0.0	0.0	N	N/A	Normal measurement
	0.9				Erase BBU RAM data
Select Test Configuration	1.1	1.1	Y	D1	DUT Configuration 1 (Standard default)
	1.2			D2	DUT Configuration 2 (fixed IF; varbl LO)
	1.3			D3	DUT Configuration 3 (varbl IF; fixed LO)
	1.4			D4	DUT Configuration 4 (fixed IF; varbl LO)
	1.5			D5	DUT Configuration 5 (varbl IF; fixed LO)
	1.6			D6	DUT Configuration 6 (2 LO's; fixed & varbl)
Sideband Selection	2.0	2.0	Y	A0	Double Sideband (no offset)
	2.1			A1	Lower Single Sideband
	2.2			A2	Upper Single Sideband
Settle Time or Delay Time	3.0	3.0	N	N/A	Normal Measurement
	3.1			ST	Display/Enter Ext LO settling time or time delay used with SP FNCT 22.1
Bandwidth Compensation	4.0	4.0	N	N0	Disable bandwidth compensation
	4.1			N1	Display/Enter DUT bandwidth & go to 4.0
	4.2			N2	Display/Enter 2nd stage BW & go to 4.0
	4.3			N3	Enable bandwidth compensation
ENR Table Selection	5.0	PREV	Y	B0	Use nominal value of ENR
	5.1			B1	Use ENR Table 1 (user must enter)
	5.2			B2	Use ENR Table 2 (user must enter)
	5.3			B3	Use ENR Table 3 (user must enter)
	5.4			B4	Use ROM ENR Table. (Special ROM required)
Measurement Mode	6.0	6.0	N	N/A	Normal Measurement
	6.1			N/A	Manual Noise Figure Measurement
X/Y Output Configurations	7.0	7.2 or 7.5	N	NP	Display NF and Gain vs Frequency on scope
	7.1			P1	Display test pattern #1 on scope
	7.2			P2	Display test pattern #2 on scope
	7.3			NQ	Display NF only vs frequency on scope
	7.4			AQ	Display Gain only vs frequency on scope
	7.5			LL	Move plotter pen to lower left
	7.6			UR	Move plotter pen to upper right
	7.7			FQ	Plot NF vs frequency on plotter*
	7.8			GQ	Plot Gain vs frequency on plotter*
	7.9			FG	Plot on strip chart, X-out=NF/Y-out=G
Display Revision	8.0	8.0	N	N/A	Normal Measurement
	8.1			N/A	Display software update number
Frequency Resolution	9.0	PREV	N	RF	Normal 1 MHz frequency resolution
	9.1			RN	100 KHz frequency resolution

S/R = Store/Recall Capability – can be stored in front panel storage registers. Y = yes, N = no
PREV = Previous value used before power down
* = Activated by single sweep

Table 3-9. Special Functions Table (Continued)

Function Type	SF Code	Power Up	S/ R	GPIB Code	Function Description
Drive for External Relays	10.0				External relay drive voltage ON only during Second Stage Calibration
	10.1				Relay drive voltage continuously ON
Measurement Selection	11.0	11.0	N	NF	Cascade NF measurement (normal mode)
	11.1			YF	Y-Factor measurement
	11.2			OP	Operating Noise Temperature (K) msmnt
	11.3			PM	Power measurement (NS off)
	11.4			PN	Power measurement (NS on)
	11.5			NE	“Noise measure” measurement
	11.6			PE	ENR measurement
Temperature Units Selection for T_{hot}, T_{cold}	12.0	PREV	N	SK	Temperature units in kelvins
	12.1			SC	Temperature units in Centigrade
	12.2			SF	Temperature units in Farenheit
Display ENR In Use	13.0	13.0	N	CO	Normal measurement
				CE	Display ENR in use at the fixed frequency
Hold and Trigger Measurement	14.0	14.0	N	T0	Normal continuous measurement
	14.1			T1	Hold measurement cycle
	14.2			T2	Execute one measurement cycle and hold
Frequency Calibration Interval Selection	15.0	15.0	N	AF	Normal automatic frequency calibration
	15.1			FC	Do an FCAL and return to 15.0
	15.2			DF	Disable auto freq calibration function
Second Stage Calibration Input Gain Selection	16.1	16.1	N	C1	Use calibration setting #1 (0, 15, 30 dB)
	16.2			C2	Use calibration setting #2 (15, 30, 40 dB)
	16.3			C3	Use calibration setting #3 (30, 40, 55 dB)
Loss Compensation Select	17.0	17.0	N	NS	No loss compensation
	17.1			LC	Use loss compensation (use with SF 18)
Display and Enter Loss Data	18.0	18.0	N	L0	Normal measurement
	18.1			L1	Enter loss before the DUT (dB)
	18.2			L2	Enter temperature of DUT before loss
	18.3			L3	Enter loss after the DUT (dB)
IF Atten Calibration	19.0	19.0	N	N/A	Normal measurement
	19.1			IC	Do IF atten calibration and go to 19.0
Voltage/ Atten Display Mode	20.0	20.0	N	V0	Normal measurement
	20.1			V1	Display E-off voltage in window A; RF attenuator setting in window B; IF attenuator setting in window C;
	20.2			V2	Display E-on voltage in window A; RF attenuator setting in window B; IF attenuator setting in window C; (with auto attenuation)
Noise Drive Indicator Function	21.0	21.0	N	LD	Noise source lamp is off
	21.1			LE	Lamp is ON when NS power is ON and OFF when NS power is OFF

Table 3-9. Special Functions Table (Continued)

Function Type	SF Code	Power Up	S/ R	GPIB Code	Function Description
Time Delay (enter time in msec. using SP FNCT 3.1)	22.0	PREV	N	GF	Normal measurement (no time delay)
	22.1	PREV	N	GS	Use time delay
Display Blanking	23.0	23.0	N	DE	Normal measurement
	23.1			DD	Blank all displays during measurement (for GPIB operations only)
Interpolation Selection	24.0	24.0	N	MC	Prohibits NF/G measurements at non-calibrated points
	24.1			MN	Uses interpolation for measurements at non-calibrated points (low accuracy)
Special Functions 30 thru 39 are service functions for use by qualified service personnel only.	30.0	30.0	N	N/A	Return for NF measurement
	30.1			N/A	Hysterisis calibration test
	30.2			N/A	Zero frequency adjust
	30.3			N/A	Low frequency adjust
	30.4			N/A	High frequency adjust
	30.5			N/A	Digital latch test
	31.0	31.0	N	N/A	Return to NF measurement
	31.1			N/A	Display test
	31.2			N/A	Keyboard test
	32.0	32.0	N	N/A	Return to NF measurement
	32.1			N/A	Memory board RAM test
	32.2			N/A	CPU board RAM test
	32.3			N/A	Scope/Plotter RAM test
	33.0	33.0	N	N/A	Return to NF measurement
	33.1			N/A	ROM-1 checksum
	33.2			N/A	ROM-2 checksum
	33.3			N/A	ROM-3 checksum
	33.4			N/A	ROM-4 checksum
	33.5			N/A	ROM-5 checksum
	33.6			N/A	ROM-6 checksum
	33.7			N/A	Total checksum of ROM's 1-6
	34.0	34.0	N	N/A	Return to normal measurement
	34.1			N/A	DMAC chip test
	34.2			N/A	GPIB chip test
	34.3			N/A	Math chip test
	35.0	35.0	N	N/A	Normal measurement
	35.1			N/A	RF Gain peak search
	36.0				Not used
	37.0	37.0	N	R0	Auto RF attenuator
	37.1			R1	Fixed RF attenuator at 0 dB
	37.2			R2	Fixed RF attenuator at 15 dB

Table 3-9. Special Functions Table (Continued)

Function Type	SF Code	Power Up	S/ R	GPIB Code	Function Description
Service Functions (continued)	37.3			R3	Fixed RF attenuator at 30 dB
	37.4			R4	Fixed RF attenuator at 40 dB
	37.5			R5	Fixed RF attenuator at 55 dB
	38.0	38.0	N	I0	Auto IF atten (mutually exclsv with 39.x)
	38.1			I1	Fixed IF attenuator at 0 dB
	38.2			I2	Fixed IF attenuator at 5 dB
	38.3			I3	Fixed IF attenuator at 10 dB
	38.4			I4	Fixed IF attenuator at 15 dB
	38.5			I5	Fixed IF attenuator at 20 dB
	39.0	39.0	N	N/A	Auto IF atten (mutually exclsv with 38.x)
	39.1			I6	Fixed IF attenuator at 25 dB
	39.2			I7	Fixed IF attenuator at 30 dB
	39.3			I8	Fixed IF attenuator at 35 dB
	39.4			I9	Fixed IF attenuator at 40 dB
	39.5			IA	Fixed IF attenuator at 45 dB
SRQ Configuration (for GPIB)	40.0	40.0	Y	N/A	Normal addressable talker/listener mode
	40.1			N/A	Talk-only mode
	40.2			N/A	Controller mode (addressing external LO)
	41.0				Not used
	41.1				
Service Request	42.0	42.0	N	NI	All SRQs disabled
	42.1			RA	SRQ on “data ready”
Service Request	43.0	43.0	N	NI	All SRQs disabled
	43.1			RC	SRQ on “calibration complete”
	44.0				Not used
	44.1				
Service Request	45.0	45.0	N	NI	All SRQs disabled
	45.1			RT	SRQ on “ready to tune”
Service Request	46.0	46.0	N	NI	All SRQs disabled
	46.1			RI	SRQ on instrument error
External LO Control Program Selection	47.0	PREV	Y	N/A	Control program for HP 8672 LO
	47.1			N/A	Control program for Wiltron 6600 Sweeper
	47.2			N/A	Not used
	47.3			N/A	Control program for HP 8350A
	47.4			N/A	Control program written by user (48.1)
External LO Control Program Parameters	48.0	48.0	N	N/A	Normal measurement
	48.1			N/A	Enter user defined control program for external LO
GPIB Output Format Selection	49.0	PREV	N	F0	Output Window C data only to GPIB
	49.1			F1	Output Window B data only to GPIB
	49.2			F2	Output Window A data only to GPIB
	49.3			F3	Output Window A and B data to GPIB
	49.4			F4	Output Window A and C data to GPIB
	49.5			F5	Output Window B and C data to GPIB
	49.6			F6	Output Window A, B, and C data to GPIB

On a front panel PRESET (GPIB Device Clear) condition, the special functions in this table will assume the same status as given in the “Power Up” column.

On a Total System Reset (Special Function 0.9), all of the special functions in this table will assume the zero condition. For example, SF 2.x will revert to 2.0; SF 4.x will revert to 4.0, etc. The only exceptions to this are:

Special Function 1.x will revert to 1.1.

Special Function 5.x will revert to its previous setting.

Special Function 7.x will revert to 7.2 or 7.6.

Special Functuion 16.x will revert to 16.1.

Special Function 47.x will revert to its previous setting.

3-47. ERROR MESSAGES

The 2075 generates error messages to provide the user with information concerning incorrect keyboard entries, operating errors, and hardware errors. There are two basic categories of error messages: Transitory and Continuous (Regenerative).

Transitory messages are displayed for two seconds and then disappear. The instrument reverts to its normal activities. Transitory messages usually indicate the denial of some illegal request on the part of the operator.

Continuous messages remain displayed until the error condition is corrected and the 2075 can function normally.

The error messages are divided into ten groups as follows:

10x	ENR Table errors
11x	Calibration errors
12x	Special Function errors
13x	Range errors
14x	RF Hardware errors
15x	Digital Hardware errors
16x	GPIB errors
17x	Measurement Data errors (GPIB)
505	System errors
9xx	System errors

All messages within a particular group will begin with the same two digits. For example, 101, 102, and 103 all belong to the first group.

When the error occurs, the 2075 front panel displays Err xxx, where xxx is the message number.

Table 3-10 lists all the error messages, their meanings, and the necessary corrective actions. Error messages are also listed on the information pull-out card in the bottom of the 2075.

Table 3-10. Error Message Table

ERROR CODE	MEANING	CORRECTIVE ACTION
101	ENR table does not exist (is cleared or empty)	Enter Frequency and ENR values or select correct ENR table. See Paragraph 3-9.
102	Attempt to modify ENR ROM table	Only tables from 5.1 - 5.3 can be modified.
103	ENR table overflow—more than 31 points entered	Enter no more than 31 calibration points in the table.
104	ENR table empty—no calibration data	Enter ENR data in the table before using it.
105	Frequency too low	Increase the frequency so that it is not lower than the lowest ENR table frequency or else enter the ENR value for that frequency.
106	Frequency too high	Decrease the frequency so that it is not higher than the highest ENR table frequency or else enter the ENR value for that frequency.
107	ENR value greater than 18 dB	Only use ENR value greater than 18 dB with proper loss compensation.
110	Measurement at non-calibrated point	Use 24.1 to override but result will be less accurate.
111	Frequency lower than calibration table	Increase the frequency so that it is within the Second Stage Calibration range or re-calibrate.
112	Frequency higher than calibration table	Decrease the frequency so that it is within the Second Stage Calibration range or re-calibrate.
113	IF attenuators not calibrated or data is wrong	Use Special Function 19.1 to re-calibrate. See Paragraph 3-36.
114	Cannot find peak during frequency calibration	Try again using Special Function 15.1. Repeated failure means hardware problem. Contact service center.
115	Calibration data not available	Do Second Stage Calibration before attempting a Noise Figure and Gain measurement.
116	Calibration error, uncalibrated RF range	DUT Gain is greater than 2075's ability to measure. Reduce Gain of DUT or measure Noise Figure only.
117	Calibration table overflow—more than 100	Calibrate with 100 or fewer points (use narrower frequency range or larger step size).

Table 3-10. Error Message Table (Continued)

ERROR CODE	MEANING	CORRECTIVE ACTION
118	Calibration error, due to RF overload	Select different range using SF 16 or check the hardware. Contact service center.
119	Cannot start a frequency calibration	Try again using Special Function 15.1. Repeated failure means hardware problem. Contact service center.
121	Special function does not exist	Use valid special function.
122	Sequence not stored	Use set sequence procedure to set the sequence before using this feature.
123	DUT Configuration has conflicting parameters	Check parameters and try again.
124	Invalid to plot Gain-only while in F-only mode	Check parameters and try again.
131	Frequency range error (Stop frequency is smaller than start frequency)	Enter appropriate frequencies.
133	The IF tuning frequency is beyond 10 to 1900 MHz	Check the DUT configuration.
134	The external LO frequency is out of range	Check the RF and IF combination.
141	RF overload (RF input too high)	Reduce the RF input power.
143	Detector overload (unable to attenuate the detector to proper level)	May have hardware problem. Contact service center.
151	Battery backup RAM error—data may be lost	Re-enter 2075 GPIB address and ENR table data. Perform IF CAL. Check to see if battery is OK.
152	RAM board error	Check board using SF 32.1.
153	ROM board error	Check board using SF 33.x.
154	GPIB board error	Check board using SF 34.2.
155	DMAC board error	Check board using SF 34.1.
156	Scope RAM error	Check board using SF 32.3.
157	A/D converter error	Use Spec Funct 20.1/20.2 to investigate.

Table 3-10. Error Message Table (Continued)

ERROR CODE	MEANING	CORRECTIVE ACTION
158	Math processor error	Check board using SF 34.3.
160	Incomplete GPIB instruction	Check instruction mnemonic and data field
161	Illegal GPIB format	Use correct GPIB format
163	Invalid GPIB code	Use correct GPIB code
164	End of ENR table data—not an error	Used as end-of-table flag
166	Illegal GPIB mode	Conflict between DUT configuration and GPIB mode.
170	Measured data is out of range	Check measurement setup.
171	Data not available	The requested data is not available in this mode.
505	System error	Check power supply voltage: +5 to +5.25 volts. If OK and errors persist, then instrument requires service.
901	System error	Check power supply voltage: +5 to +5.25 volts. If OK and errors persist, then instrument requires service.
910	System error	Check power supply voltage: +5 to +5.25 volts. If OK and errors persist, then instrument requires service.
911	System error	Check power supply voltage: +5 to +5.25 volts. If OK and errors persist, then instrument requires service.
912	System error	Check power supply voltage: +5 to +5.25 volts. If OK and errors persist, then instrument requires service.
913	System error	Check power supply voltage: +5 to +5.25 volts. If OK and errors persist, then instrument requires service.
914	System error	Check power supply voltage: +5 to +5.25 volts. If OK and errors persist, then instrument requires service.
920	System error	Check power supply voltage: +5 to +5.25 volts. If OK and errors persist, then instrument requires service.

3-48. STORE-RECALL REGISTERS

The 2075 can save the current front panel control parameters and then recall them for re-use at a later time. Nine front panel storage registers (Register 1 through Register 9) are available for storing up to nine sets of control parameters. A tenth register, Register 0, saves current control parameters when a PRESET is done. The parameters which are stored are listed in Column 4 of Table 3-3.

To store a set of control parameters, in Register 3 for example, press:

STORE 3 ENTER

The control parameters currently in use are stored in Register 3 and they also remain as the active parameters.

To recall a previously stored set of control parameters, from Register 8 for example, press:

RECALL 8 ENTER

The control parameters which were stored in Register 8 immediately become the active control parameters.

The 2075 can also recall sets of previously stored control parameters in any sequence. The normal recall sequence is from Register 1 through Register 9. To recall in sequence press:

SEQ ENTER

The next register in sequence is recalled and its number is displayed in Window A.

To program a new recall sequence press:

SHIFT SEQ *the numeric keys of the sequence* ENTER

For example, if the new desired sequence is 1,2,3,1,2,3,1,2,3 then the keystroke sequence is:

SHIFT SEQ 123123123 ENTER

Any sequence can be programmed up to a maximum of 9 digits in length.

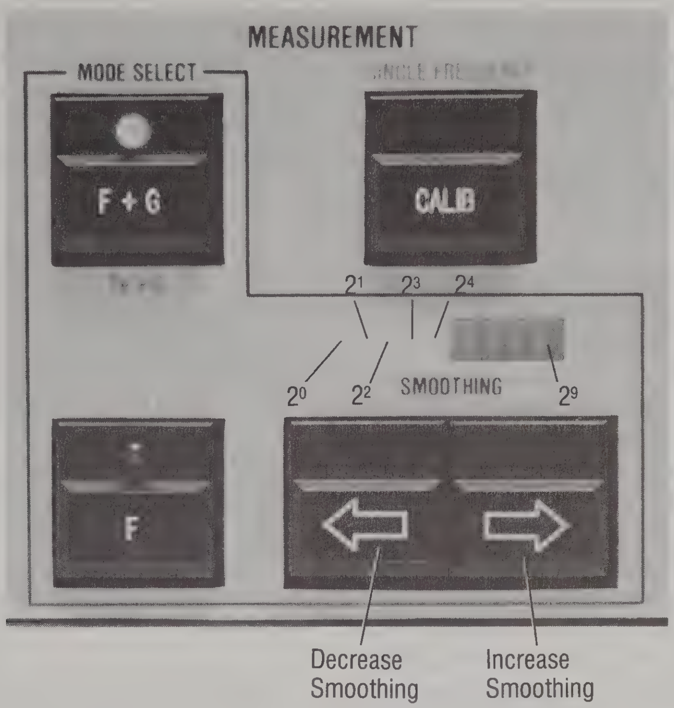
3-49. SMOOTHING FUNCTION

Smoothing can be employed to reduce “jitter” in displayed noise and gain measurements. When smoothing is not in use, each measurement result is displayed immediately. Small, random variations in readings can appear as very rapid changes in the least significant digits of the displayed values.

Smoothing is an averaging function. When smoothing is employed, each measurement is made many times and the results are averaged together. Then the average value is displayed on the front panel. Increasing the amount of smoothing increases the number of measurements made and averaged together, before the average value is displayed.

To increase smoothing press the **RIGHT ARROW** key. Each time the key is pressed, smoothing is increased by one increment. Depress and hold the **RIGHT ARROW** key to add multiple increments. To decrease smoothing, use the **LEFT ARROW** key in similar fashion.

Smoothing is increased or decreased in powers of two. The smoothing indicator is a group of ten LED light bars. The leftmost bar represents 2 to the 0 power. The rightmost bar represents 2 to the 9th power. When minimum smoothing is in use, only the leftmost bar is lit and this indicates that 2 to the 0 power (1) readings are taken and averaged before the result is displayed. Each additional bar, when lit, indicates an increase, by a power of two, in the number of readings taken and averaged before displaying the result. When all the bars are lit, 2 to the 9th power (512) readings are taken and averaged together before the result is displayed. See Figure 3-32.



Each light bar, when illuminated, indicates a power of 2 increase in the number of readings taken before the result is displayed.

Figure 3-32. SMOOTHING INDICATOR

The term SMOOTHING NUMBER refers to the number of LED bars that are lit. If all 10 bars are lit, the smoothing number is 10.

The term SMOOTHING FACTOR refers to the number of measurements taken and averaged before the result is displayed. The smoothing factor is equal to 2 raised to that power which is equal to the smoothing number minus 1. See the equation below:

$$\text{Smoothing Factor} = 2^{(\text{Smoothing Number} - 1)}$$

The 2075 uses two different methods of calculating the displayed value. When swept measurements are made, an arithmetic method is used. In this method, the number of readings taken is equal to the smoothing factor and the readings are averaged to produce the displayed value. The formula for this method is shown:

$$\text{Displayed Value} = \frac{\text{Sum of S measurements}}{S}$$

Where S is the smoothing factor.

In arithmetic smoothing, the display is updated every time that S readings have been taken.

When fixed frequency measurements are made, the smoothing factor is applied exponentially. This smoothing algorithm is designed to give progressively greater weight to prior measurements as the smoothing factor is increased. The formula for the exponential method is as follows:

$$\text{Displayed Value} = \frac{P(S-1) + D}{S}$$

Where:	P is the Previous Data Value	(the cumulative previous displayed average)
	D is the Present Data Value	(the single reading just taken)
	S is the Smoothing Factor in use	

As an example, assume a smoothing factor of 32. The above formula becomes:

$$\text{Displayed Value} = \frac{P(32-1) + D}{32} \text{ or } \frac{31P + D}{32}$$

The process of taking S number of readings is referred to as a measurement cycle. For exponential smoothing, the value of P is cumulative through the measurement cycles. Thus, as more measurement cycles are made, the displayed value becomes even more stable.

The following table shows this effect. Column 1 shows the numeric sequence of the measurements. That is, 10 measurements are shown and the sequence is from 1 to 10 (or top to bottom). Column 2 shows the actual reading for each single measurement. The remaining 5 columns show what average value is actually displayed on the front panel when a given smoothing factor is in use. For example, in Column 3, which is for a smoothing factor of 1, each displayed value is exactly the same as the single measurement just taken. In Column 4, which is for a smoothing factor of 2, each displayed value is the average of the last reading just taken and the previous average. To illustrate, the second entry in Column 4 is 2.50 which is the average of the first 2 measurements; 2.52 and 2.48 from column 1. The third entry in Column 4 is 2.53 and this is the average of 2.56 and 2.50.

Note that as the smoothing factor is increased, the displayed value becomes quite stable. Of course, as the smoothing factor is increased, more time is required for the display to show a change.

Measurement Number	**Actual Measurement**	**DISPLAYED VALUE**				
		Smoothing Factor				
		1	2	4	8	128
1	2.52	2.52	2.52	2.52	2.52	2.52
2	2.48	2.48	2.50	2.51	2.52	2.52
3	2.56	2.56	2.53	2.52	2.52	2.52
4	2.53	2.53	2.53	2.52	2.52	2.52
5	2.49	2.49	2.51	2.52	2.52	2.52
6	2.45	2.45	2.48	2.50	2.51	2.52
7	2.44	2.44	2.46	2.48	2.49	2.52
8	2.45	2.45	2.46	2.48	2.49	2.52
9	2.45	2.45	2.45	2.47	2.49	2.52
10	2.44	2.44	2.45	2.46	2.48	2.52

3-50. 100 KHZ DISPLAY RESOLUTION

The normal frequency display resolution of the 2075 is 1 MHz. This resolution can be increased to .1 MHz by Special Function 9.1.

When normal 1 MHz resolution is in use, the frequency display does not show a decimal place. A frequency of 100.9 MHz, for example, will be displayed as 100 MHz. When .1 MHz resolution is in use, one decimal place is shown and the example frequency displayed is 100.9 MHz.

Because Test Configuration 1 operates within the basic 10 MHz to 1900 MHz range of the instrument, use of .1 MHz resolution is practical in this configuration. In Test Configurations 2 through 6, which operate at much higher frequencies, this feature is not practical and cannot be used.

It is important to note that even if .1 MHz display resolution is not in effect, the user can still increment the frequency in steps as small as .1 MHz. In such a case, the display will not show the fractional steps. For instance, if the frequency is incremented in .1 MHz steps, from 100.0 MHz to 101.0 MHz, the display will continue to show 100 MHz while the frequency is changing from 100 MHz through 100.9 MHz.

To select .1 MHz resolution press:

SPEC FUNC 9.1 ENTER

To select 1 MHz resolution press:

SPEC FUNC 9.0 ENTER

The GPIB code to select .1 MHz resolution is RN.

The GPIB code to select 1 MHz resolution is RF.

3-51. SOFTWARE REVISIONS

A special function is used to display the software update level of the 2075. To determine the software update level press:

SPEC FUNC 8.1 ENTER

The update level is displayed in Window A as SU-X, where X is the update level number. Software Update Level 6 would be displayed as SU-6.

This manual is written to software update 6. The following changes have been incorporated in SU-6:

1. The maximum input frequency that can be measured at the input port is now 1900 MHz (specifications apply up to 1850 MHz).

2. There is no minimum allowable entry for ENR values. The maximum allowable ENR value is now 80 dB.

   The maximum usable effective ENR is 18 dB. That is, values of up to 80 dB can be entered. However, these can be used by the 2075 during calculations, only if sufficient loss compensation (Loss 1) is employed so that ENR (dB) minus Loss 1 (dB) is no greater than 18 dB.

   NOTE

   ENR is always entered as dB, however it may be displayed as dB or as a ratio. When entering a value down to -9.99 dB, the display will show dB. However when entering a value below -9.99 dB, the display will automatically show the value as a ratio.

3. The maximum allowable frequency for an ENR value is now 65,535 MHz.

4. The maximum RF frequency measurable is now 65,535 MHz.

5. The allowable range of entries for T_{hot} is now 0 to 18,588 kelvins.

6. Special Function 15.2 disables the automatic periodic FCAL and also disables the FCAL at the beginning of Second Stage Calibration.

7. During any Test Configuration the 2075 can be placed in any GPIB mode.

8. During Second Stage Calibration, pressing the **CALIB** key stops the calibration but the calibration data taken up to that point is retained. However, the CAL1 step must have been

completed before the **CALIB** key was pressed. When this is done the instrument goes into uncorrected mode. However, it can be returned to corrected mode by pressing the **F + G** key.

Where heavy smoothing is in use, performing all the steps of Second Stage Calibration can take a long time. This feature avoids the need to complete all three steps (CAL1, CAL2, and CAL3) of the Second Stage Calibration. However, the user must be sure that when the measurement is made, the DUT gain is flat enough so that the 2075 does not need to use a different input gain setting. Otherwise the instrument will use old calibration data for that gain setting and the measurement will be erroneous.

9. When manual Noise Figure measurements are made, the instrument can now be operated in Talk Only Mode for outputting data to a printer.

10. When a Gas Discharge type noise source is used, the delay time can be entered by the user and its allowable range is from 1 msec to 10 seconds. The value is always entered in milliseconds. As an example, to enter a delay time of 2 seconds, press:

    SPEC FUNC 3.1 ENTER

    2000 ENTER

    To activate usage of this delay time, press:

    SPEC FUNC 22.1 ENTER

    NOTE

    Where an external local oscillator is used, the value entered under Special Function 3.1 is used for the local oscillator settling time. This same value is also used for the trigger delay time if Special Function 22.1 has been activated.

11. The user defined control program for external local oscillators now has an additional control character: Control G = decimal 7 = ASCII BEL. The 2075-2A will interpret this character to mean that the frequency units for the external LO are in GHz.

12. A new special function has been added; Special Function 10.0. Special Function 10.0 causes voltage to be applied to external relays only during Second Stage Calibration. Special Function 10.1 causes voltage to be always applied to the external relays.

13. A new GPIB code has been added which allows any special function to be set via the bus. This new code is SP. To set any special function over the bus, send:

    SP XX.X ET

    Where XX.X is the numeric code for that special function.

14. The absolute need to send the UNTALK command to the 2075-2A after it has been ADDRESSED TO TALK and then has finished talking, is no longer necessary.

SECTION 4

GPIB OPERATION

4-1. INTRODUCTION

This section of the manual provides information related to operation of the 2075 over the General Purpose Interface Bus. Whereas operating procedures in general are covered in Section 4 of this manual, this section provides the necessary additional information to accomplish those procedures over a GPIB. This section assumes that the user has some familiarity with operation and programming of GPIB devices.

4-2. GPIB GENERAL INFORMATION

This paragraph is included to provide some basic information and concepts related to operation of the General Purpose Interface Bus.

The GPIB is a standardized digital interface system which allows the exchange of digital data and commands between programmable electronic instruments. The GPIB was first established as a standard by the Standards Board of the Institute of Electrical and Electronic Engineers (IEEE) in 1975. The defining document, IEEE-488 1975, was published in that year. After minor editorial revisions, the document was republished in 1978 as IEEE-488 1978.

The IEEE standard was adopted by the American National Standards Institute (ANSI) in 1976 and was published as ANSI Standard MC 1.1. The user should refer to either of these documents for detailed information regarding operations of the GPIB.

As many as 15 devices can be connected to the bus at one time. There are 4 basic types of devices and these are classified according to the 3 basic bus functions which they perform: CONTROLLER, TALKER, LISTENER, and TALKER/LISTENER. The CONTROLLER manages the bus and tells the other devices when to talk and when to listen. Only the controller can send commands but it can also send and receive data. A TALKER can send data. A LISTENER can receive data. A TALKER/LISTENER can send and receive data.

The CONTROLLER commands a device to talk by sending an ADDRESS TO TALK command to that device. The CONTROLLER commands a device to listen by sending an ADDRESS TO LISTEN command. Since an address is used as part of the command, only the device having that address will comply with that command.

There can be only one active controller on the bus. Some GPIB applications use two or more controller devices, but in such cases active control of the bus is switched back and forth between them. Thus, there is still only one active controller at any given time.

At any one time, only one device on the bus can be the talker. However, when a device is talking there can be several listeners at the same time.

The GPIB is a 24 wire interface. Of the 24, eight wires are common return lines and 16 wires are signal lines. The 16 signal lines are grouped as 8 data lines, 5 bus control lines, and 3 handshake lines. These are shown in Figure 4-1.

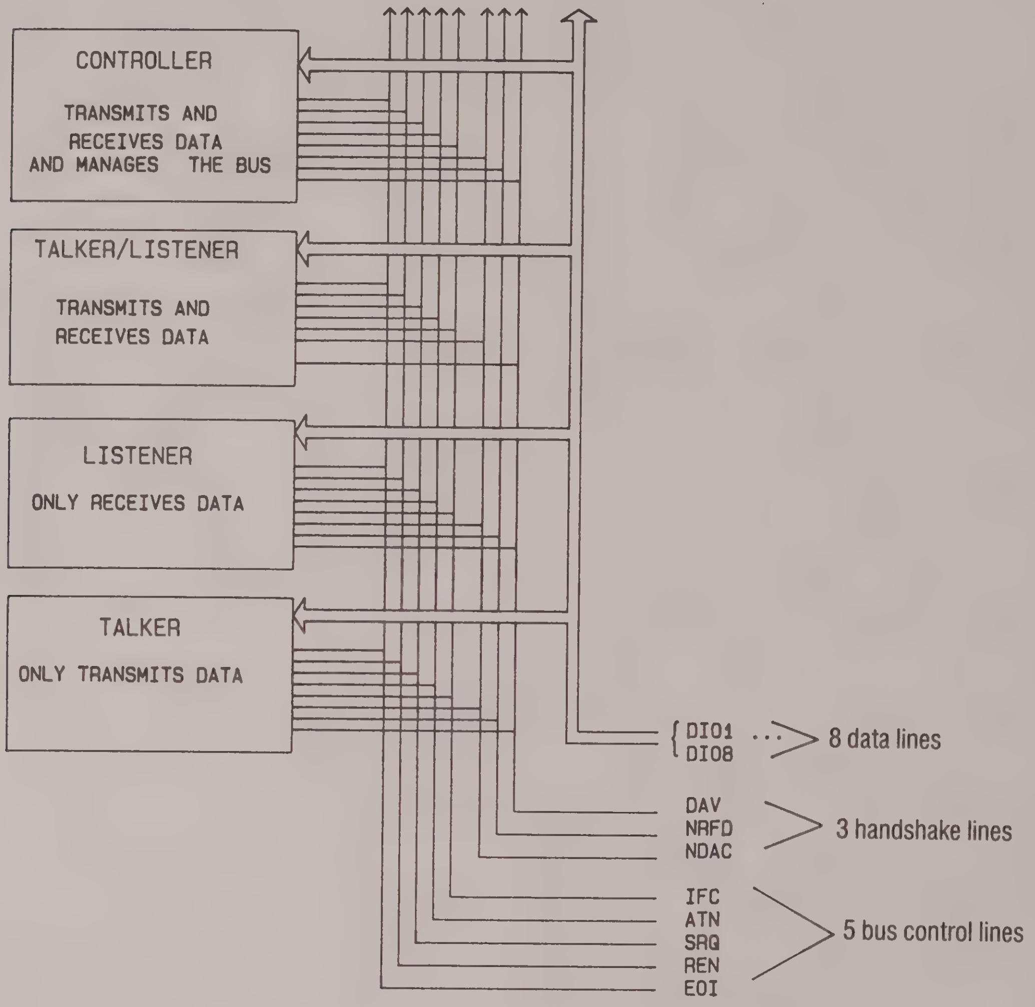


Figure 4-1. GENERAL PURPOSE INTERFACE BUS

The bus is operated in two basic modes: Command Mode and Data Mode. The controller places the bus in Command Mode by setting the ATN line to TRUE. In this mode the controller can transmit multiline commands on the 8 data lines or it can transmit single line commands by setting the states of the bus control lines. Commands belong to either the Universal Command Group (UCG) or the Addressed Command Group (ACG). All devices on the bus respond to a UCG commmand. Only the addressed device will respond to an ACG command. Both the ADDRESS TO TALK and the ADDRESS TO LISTEN command are ACG commands.

The controller places the bus in Data Mode by setting the ATN line to FALSE. In Data Mode, data is transmitted on the 8 data lines and it is normally encoded in 7 bit ASCII format with the 8th bit used for parity. Data transmission occurs in a byte serial, bit parallel mode. Any talker can place data on the bus, but only after it has been addressed to talk by the controller.

The 3 handshake lines carry the signals DAV, NRFD, and NDAC. These three lines are used to establish the correct timing of the asychronous data exchanges between all devices. The states of these lines can be read or set by any device as part of the handshake process.

The 5 bus control lines carry the signals ATN, REN, IFC, SRQ, AND EOI. Only the controller can set the states of the ATN, REN, and IFC lines. The SRQ line can be set by any device (except the controller) when it requests service from the controller. The EOI line state can be set by any device, including the controller, when it is being a talker. The 5 bus control lines are used to send single line messages.

For more detailed information on GPIB operation refer to IEEE-488 1978 or ANSI MC 1.1.

4-3. GPIB OPERATING MODES

The 2075 can be operated in three different and mutually exclusive GPIB modes which are Normal TALKER/LISTENER, TALK ONLY (TALK ALWAYS), and LIMITED CONTROLLER. Special Function 40 is used to select the mode.

Normal TALKER/LISTENER is the mode used when the 2075 is controlled by an external GPIB compatible controller. The 2075 assumes this mode upon power-up. However, it is still in local mode and is controllable from the front panel until the external controller sends the first ADDRESS TO LISTEN command. Upon receipt of this command the 2075 goes into remote mode, control reverts to the external controller, and the front panel is locked out (except for the LOCAL key). The 2075 can LISTEN or TALK while in this mode.

To select this mode press:

SPEC FUNC   40.0   ENTER

TALK ONLY (or TALK ALWAYS) mode is a local mode, in which the front panel controls are used to operate the 2075. This mode is used to send measurement data to a GPIB compatible printer, when no external controller exists. To select this mode press:

SPEC FUNC   40.1   ENTER

LIMITED CONTROLLER mode is used when the 2075 controls the operation of an external local oscillator and no external controller exists. This is a local mode and control is therefore accomplished from the front panel. To select this mode press:

SPEC FUNC   40.2   ENTER

4-4. SETTING THE GPIB ADDRESS

The GPIB address of the 2075 can be entered through the front panel when the unit is in a local mode. To enter the address (for example, 15), press:

LOCAL   15   ENTER

The current address can be displayed by pressing only the **LOCAL** key.

The GPIB address is saved when the unit is powered-off. It is also saved when the unit is preset by pressing the **PRESET** key. When a total system reset is performed (Special Function 0.9) the current address is lost and it is set to the default value of 8.

4-5. GPIB COMPATIBILITY

The 2075 can interface with any GPIB compatible controller or computer. The GPIB functional capabilities of the 2075, as defined by IEEE-488 1978, are shown in Table 4-1.

Table 4-1 GPIB Functional Capabilities

AH1	Complete acceptor handshake
SH1	Complete source handshake
T5	Complete talker
L4	Complete listener, except no LISTENER ONLY
SR1	Complete Service Request
RL1	Complete Local/Remote
PPO	No parallel poll
DC1	Complete Device Clear
DT1	Complete Device Trigger
C1	System Controller
C3	Capable of sending REN
C28	Capable of sending interface message only

Note that the mnemonic codes are not control codes for the 2075.

For a more detailed explanation of the codes above refer to IEEE-488 1978 or ANSI Standard MC 1.1.

4-6. REMOTE AND LOCAL MODES

When the 2075 is in the LOCAL mode, all control is accomplished via the front panel keys. When the 2075 is in the REMOTE mode, it is controlled by an external controller and the front panel keys are locked out. However, the **LOCAL** key on the front panel is not locked out unless the controller has sent a local lockout message.

The 2075 is always in local mode when it is in the TALK ONLY (TALK ALWAYS) or LIMITED CONTROLLER mode.

When the instrument is powered up it assumes the normal TALKER/LISTENER mode by default, and it is also in local mode. The 2075 goes into the remote mode only when it is in normal TALKER/LISTENER mode, and only after the external controller has placed it in remote. To do this, the controller first sets the REN (Remote enable) line TRUE, and then sends an ADDRESS TO LISTEN command to the 2075. If no external controller exists, the unit will remain in local mode.

The RMT (REMOTE) annunciator in Window A is lit when the unit is in the remote mode.

The 2075 can always communicate via the GPIB regardless of the mode it is in. However, it can receive data or commands from an external device only when in the normal TALKER/LISTENER mode.

4-7. GPIB MESSAGE TYPES

The 2075 communicates on the GPIB interface by sending or receiving four basic categories of messages. These are:

INTERFACE BUS MESSAGES

DEVICE MESSAGES

DATA MESSAGES

STATUS MESSAGES

4-8. INTERFACE BUS MESSAGES

These are commands sent by the controller to the devices on the bus when the bus is in the Command Mode (ATN line is TRUE). Most of these are multiline messages and all belong to either the ACG or UCG. These messages are defined by IEEE-488 1978 and all are device independent. That is, the manner in which the message is transmitted does not vary from one type of device to another. These messages are listed in Table 4-2 on page 4-6.

DEVICE CLEAR Message

The DEVICE CLEAR message clears the current control parameters from the 2075 and causes it to assume the PRESET control parameters. That is, the CLEAR command has the same effect as depressing the front panel **PRESET** key. The CLEAR or PRESET control parameters are listed in Table 3-3.

The 2075 also responds to the SELECTIVE DEVICE CLEAR command (an ACG command) when it is addressed to listen. It will respond to the DEVICE CLEAR command (a UCG command) whether addressed or not.

TRIGGER Message

The GROUP EXECUTE TRIGGER Message causes the 2075 to execute one complete measurement cycle according to its previously programmed parameters. The 2075 must be addressed to listen to receive this multiline message.

The program message, T2, causes the same response as the GROUP EXECUTE TRIGGER message. Hovever, the 2075 must previously have been set to the HOLD mode by the program message T1.

REMOTE Message

The REMOTE message places the 2075 in the remote mode. The REMOTE message is sent in two steps: first, the REN line is set to TRUE by the controller, and second, the ADDRESS TO LISTEN command is sent. The 2075 does not actually switch into remote until it receives the ADDRESS TO LISTEN command.

When the instrument switches from local to remote, none of the front panel control parameters are changed. However, the front panel keys, except **LOCAL** are disabled. When in the remote mode, the RMT annunciator is lit and any changes in control parameters must come from the controller.

LOCAL Message

The LOCAL message is the GO TO LOCAL (GTL) bus command. When the 2075 is in remote mode and it receives this message from the controller, it will respond by going to local mode. Control is returned to the front panel keys.

If the instrument is in LOCAL LOCKOUT when the LOCAL message is received, front panel control is still returned but the LOCAL LOCKOUT is not cleared. This means that the next time the 2075 is placed back into remote, the **LOCAL** key will be disabled. This can be avoided by sending the CLEAR LOCKOUT/SET LOCAL message when commanding the instrument to go to local.

Changing the instrument from remote to local mode does not change any of the control parameters.

When the 2075 is in the remote mode and local lockout is not in effect, it can be returned to local by pressing the **LOCAL** key. It is possible, however, for this action to cause the loss of any data message currently being sent. This can be avoided by enabling local lockout, and by returning the instrument to local using the appropriate command from the controller.

LOCAL LOCKOUT Message

If the 2075 is in the remote mode, the LOCAL LOCKOUT command causes it to disable the front panel **LOCAL** key.

If the 2075 is in local and the REN (Remote Enable) line is set to TRUE, the LOCAL LOCKOUT will not cause any immediate change. However, the first time it is addressed to listen, it will switch into remote mode and the **LOCAL** key will be locked out.

When local lockout is in effect the 2075 can be returned to local mode by any of the following:

a. the LOCAL message

b. the CLEAR LOCKOUT/SET LOCAL message

c. setting the POWER switch to OFF and then back to ON

d. removing the GPIB cable

CLEAR LOCKOUT/SET LOCAL Message

The controller sends the CLEAR LOCKOUT/SET LOCAL message by setting the REN line to FALSE. The 2075 responds to this command by returning to local mode, clearing the local lockout, and restoring control to the front panel keys. The transition from remote to local does not change any of the instrument control parameters.

INTERFACE CLEAR Message

The controller sends the IFC (UCG) message by setting the IFC (Interface Clear) bus control line to TRUE. Upon receipt of this command, the 2075 and all other devices on the bus stop talking or listening, and return to LOCAL.

Table 4-2. GPIB Function Reference Table

GPIB MESSAGE	RESPONSE	RELATED COMMANDS & CONTROLS	INTERFACE FUNCTIONS
Interface Clear	The Noise-Gain Analyzer stops talking or listening and returns to LOCAL.	IFC (UCG)	ALL
Device Clear	The Noise-Gain Analyzer is set to the same conditions established by pressing the PRESET key. Refer to Table 3-3.	DCL(ACG) SDC(UCG)	DC1
Clear Lockout/ Set Local	The Noise-Gain Analyzer returns to local (front panel control) and local lockout is cleared when the REN bus control line goes FALSE. When entering local mode, no instrument settings or functions are changed.	DISABLE REN (UCG)	RLI
Local	The Noise-Gain Analyzer returns to local mode (front panel control). It responds equally to the GTL bus command and the front panel LOCAL key. When entering the local mode, no instrument settings or functions are changed.	GTL(ACG)	PL1
Local Lockout	Disables the LOCAL key so that only the controller can return the Noise Gain Analyzer to local.	LLO(UCG)	RL1
Remote	The instrument is allowed to enter the Remote mode when the REN bus control line is TRUE. However, remote mode is not entered until the first time it is addressed to listen. The front panel REMOTE annunciator lights when the instrument is actually in the remote mode. When entering the remote mode, no instrument settings or functions are changed, but all front panel keys except LOCAL are disabled. All instrument control now comes from GPIB.		RL1 L4

* Commands, Control Lines, and Interface Functions are defined in IEEE-488, 1978. Knowledge of these may not be necessary if your controller's manual describes programming in terms of the GPIB Messages shown in the left column, or a similar program command.

* ACG = Addressed Command Group. UCG = Universal Command Group.

Table 4-2. GPIB Function Reference Table (Continued)

GPIB MESSAGE	RESPONSE	RELATED COMMANDS & CONTROLS	INTERFACE FUNCTIONS
Require Service	The Noise-Gain Analyzer sets the SRQ bus control line TRUE to request service for the controller based on certain conditions specified in Special Functions 41 through 45.	SRQ	SR1 T5
Serial POLL	The Noise-Gain Analyzer responds to a Serial Poll Enable (SPE) bus command by sending an 8 bit byte when addressed to talk. If the instrument is holding the SRQ control line TRUE (issuing Require Service message), bit 7 (RQS bit) in the Status Byte, and the bit representing the condition causing the Require Service message to be issued, will both be TRUE. The bits in the Status Byte are latched but can be cleared by: 1. Removing the causal condition, and 2. Reading the Status Byte.	SPE(ACG) SPD(ACG)	T5
Trigger	If in remote and addressed to listen, the Noise-Gain Analyzer makes one measurement according to the previously programmed setup. It responds equally to bus command GET and program code T2, Trigger Execute (a Data Message). Before using Trigger, the instrument should first be set to a Hold mode using program code T1.	GET(UCG)	DT1

* Commands, Control Lines, and Interface Functions are defined in IEEE-488, 1978. Knowledge of these may not be necessary if your controller's manual describes programming in terms of the GPIB Messages shown in the left column, or a similar program command.

* ACG = Addressed Command Group. UCG = Universal Command Group.

4-9. DEVICE MESSAGES

These are the messages or codes used to remotely program the 2075 to set up and then execute measurements. Some of these messages are parameter codes which are used to enter numeric values, such as start frequency, stop frequency, etc. to be used during the measurement. Others are mode commands which tell the 2075 to set some mode or special function which is to be used during the measurement. Still others are used to execute some function such as calibration or measurement.

These are all device dependent messages which are specific to the 2075. Each of these messages is a two character (two byte) code and the 2075 must be addressed to listen in order to receive these codes. The controller sends these messages to the 2075 when the bus is in the Data Mode (the ATN line is set to FALSE by the controller).

The device messages are listed in Tables 4-3 and 4-4.

Device Message Formats

Device messages are sent either as single messages (one at a time) or as multiple messages (a group of messages). The format for single messages is slightly different from that for multiple messages. A multiple message may have a separator between each single message in the group and uses a line terminator only at the end of the group. A single message has no separators but is also ended with a line terminator.

Single messages are formatted as follows:

	Header	**Data**	**Data Terminator**	**Line Terminator**
Example:	SS	150	MZ	[CR] [LF]

Note that the example above is a single message which requires a numeric data entry and therefore has a data terminator. For a single message which requires no numeric data entry, the format is as follows:

	Header	**Line Terminator**
Example:	DG	[CR] [LF]

Note that the line terminator for the message is Carriage Return/Line Feed.

A multiple message is formatted as follows:

	Header	**Data**	**Data Terminator**	**Separator**
	Header	**Data**	**Data Terminator**	**Separator**
	Header	**Data**	**Data Terminator**	**Line Terminator**
Example:	FA	10	MZ	,
	FB	10	MZ	,
	SS	10	MZ	[CR] [LF]

Note that the separator in the above example is a comma and that the line terminator is Carriage Return/Line Feed. A space could have been used for the separator instead of a comma. The terms are explained below.

The Header is the two character code that corresponds to a front panel key or special function. These are listed in Table 4-3 and 4-4. Some examples are SS (Step Size) and FA (Start Frequency).

Data is the numeric value representing the quantity associated with the header. Some headers do not require a data value.

The Data Terminator must follow every data entry. The data terminator usually defines the quantity which is represented by the numeric value. The allowable data terminators are MZ (Megahertz), DB (Decibels), DG (Temperature), and ET (the ENTER key). No other data terminator is acceptable.

The Separator is a convenience feature which makes a multiple message easier to read by separating its individual messages. The separator may be a comma or a space. If preferred, a separator need not be used at all. The following examples show three different ways of entering the same multiple message. The example message sets Start Frequency to 10 MHz, Stop Frequency to 100 MHz, Step Size to 10 MHz, Gain Upper Limit to 40 dB, and Gain Lower Limit to 0 dB.

Comma as separator

FA10MZ,FB100MZ,SS10MZ,UG40DB,LG0DB [CR] [LF]

Space as separator

FA10MZ FB100MZ SS10MZ UG40DB LG0DB [CR] [LF]

No separators

FA10MZFB100MZSS10MZUG40DBLG0DB [CR] [LF]

The Line Terminator is the delimiter used to indicate the end of a message. It is the Carriage Return/Line Feed sequence. Depending on how the controller is programmed, the Line Feed may be sent with the EOI line set TRUE or FALSE. Either method is acceptable to the 2075. In a computer where the program is written in some higher level language such as BASIC, the terminators are inserted automatically and will not appear in the program line.

Table 4-3. Table of GPIB Codes

GPIB CODE	PARAMETER
A0	Double Sideband
A1	Lower Single Sideband
A2	Upper Single Sideband
AF	Normal automatic frequency calibration
AQ	Display gain (only) vs. frequency on scope
B0	Use ENR TABLE 0 with nominal values
B1	Use ENR Table 1. User must enter
B2	Use ENR Table 2. User must enter
B3	Use ENR Table 3. User must enter
B4	Use ROM ENR Table. Special ROM required
C1	Use calibration setting #1
C2	Use calibration setting #2
C3	Use calibration setting #3
CA	Second Stage Calibration
CE	Display ENR in use
CO	Normal measurement
CT	Clear ENR table in ENR mode
D1	DUT Configuration 1
D2	DUT Configuration 2
D3	DUT Configuration 3
D4	DUT Configuration 4
D5	DUT Configuration 5
D6	DUT Configuration 6
DB	Terminator for dB unit entries
DD	Blank all displays during measurement
DE	Normal measurement
DF	Disable automatic frequency calibration
DG	Terminator for degree unit entries
EF or EN	Disable ENR entry mode
EN only	Enable ENR entry mode
ET	General entry terminator code

Table 4-3. Table of GPIB Codes (Continued)

GPIB CODE	PARAMETER
F0	Output window C data only
F1	Output window B data only
F2	Output window A data only
F3	Output window A & B data
F4	Output window A & C data
F5	Output window B & C data
F6	Output window A, B & C data
FA	START FREQ prefix
FB	STOP FREQ prefix
FC	Do a frequency calibration
FF	Front panel FIXED FREQ key
FG	X-out = NF/Y-out = gain (on strip chart)
FQ	Plot NF vs frequency on plotter
GD	Front panel Gain RATIO/dB key at dB setting
GF	Normal measurement (no time delay)
GQ	Plot gain vs frequency on plotter
GR	Front panel Gain RATIO/dB key at RATIO setting
GS	Time delay to ignite gas source (1 msec)
I0	IF Autorange
I1	IF attenuator setting 1
I2	IF attenuator setting 2
I3	IF attenuator setting 3
I4	IF attenuator setting 4
I5	IF attenuator setting 5
I6	IF attenuator setting 6
I7	IF attenuator setting 7
I8	IF attenuator setting 8
I9	IF attenuator setting 9
IA	IF attenuator setting 10
IC	Execute IF attenuator calibration
IF	IF FREQ prefix
L0	Normal measurement
L1	Enter loss before the DUT (dB)
L2	Enter temperature of the losses
L3	Enter the loss after the DUT (dB)
LC	Use loss compensation (use with SF 18)
LD	Noise drive indicator disable
LE	Noise drive indicator enable
LG	Lower gain limit
LL	Move plotter pen to lower left
LN	LOWER LIMIT (NOISE) prefix
LO	LO FREQ prefix

Table 4-3. Table of GPIB Codes (Continued)

GPIB CODE	PARAMETER
MC	Prohibit NF/G measurements at non-calibrated points
MN	Use interpolation at non-calibrated points
MZ	Terminator for MHz unit entries
N0	Disable bandwidth compensation
N1	Bandwidth #1 prefix
N2	Bandwidth #2 prefix
N3	Enable bandwidth compensation
ND	Front panel NF RATIO/dB on dB setting
NE	Measure noise measure (M)
NF	Measure cascade noise figure
NG	Measure first stage noise figure and gain
NI	All SRQs disabled
NP	Normal oscilloscope (NF and Gain vs Freq)
NQ	Display NF (only) vs Freq on oscilloscope
NR	Front panel NF RATIO/dB in RATIO setting
NS	Loss compensation off
OP	Measure operating noise temperature
P1	Display test pattern #1 on oscilloscope
P2	Display test pattern #2 on oscilloscope
PM	Power measurement (NS off)
PN	Power measurement (NS on)
R0	RF auto-range
R1	RF attenuator setting 1
R2	RF attenuator setting 2
R3	RF attenuator setting 3
R4	RF attenuator setting 4
R5	RF attenuator setting 5
RA	SRQ on data ready
RC	SRQ on calibration complete
RF	1 MHz frequency resolution
RI	SRQ on instrument error
RN	100 KHz frequency resolution
RT	SRQ on ready to tune

GPIB CODE	PARAMETER
S0	Smoothing factor = 1
S1	Smoothing factor = 2
S2	Smoothing factor = 4
S3	Smoothing factor = 8
S4	Smoothing factor = 16
S5	Smoothing factor = 32
S6	Smoothing factor = 64
S7	Smoothing factor = 128
S8	Smoothing factor = 256
S9	Smoothing factor = 512
SC	Temperature units in degrees Centigrade
SF	Temperature units in degrees Fahrenheit
SG	SWEEP SINGLE
SK	Temperature units in kelvins
SL	SECOND LO FREQ
SN	SWEEP off
SP	SPECIAL FUNCTION
SR	SWEEP AUTO
SS	STEP SIZE prefix
ST	Settling time
TO	Normal continuous measurement
TI	Hold measurement
T2	Execute one measurement cycle and hold
TC	T_{cold} (K) prefix
TE	T_e measurement mode
TG	T_e + G measurement mode
TH	T_{hot} (K) prefix
UG	UPPER LIMIT GAIN prefix
UN	UPPER LIMIT NOISE prefix
UR	Move plotter pen to upper right
V0	Normal measurement
V1	Display E-off in window A; RF attenuator setting in window B; IF attenuator setting in window C
V2	Display E-on in window A; RF attenuator setting in window B; IF attenuator setting in window C
YF	Y-factor for noise figure

Table 4-4. Front Panel Keys and Equivalent GPIB Codes

KEY #	NON-SHIFTED FUNCTION	GPIB CODE	SHIFTED FUNCTION	GPIB CODE
1	PRESET	DC or SDC*	N/A	
2	SPEC FUNC	N/A	N/A	
3	SHIFT	N/A	N/A	
4	LOCAL	N/A	EXT LO ADDRESS	
6	ENR	EN	T_{hot} (K)	TH
	Toggle ENR OFF	EF	N/A	
7	ON/OFF Cycle	N/A	T_{cold} (K)	TC
12	RATIO or dB (Gain)	GR/GD	N/A	
15	RATIO or dB (NF)	NR/ND	N/A	
16	CALIB	CA	SINGLE FREQ calibration	
19	Incr Smoothing	S0 thru S9		
20	Decr Smoothing	No direct equivalent		
22	F + G	NG	T_e + G	TG
23	F	NF	T_e	TE
	0	0	N/A	
	1	1	N/A	
	2	2	N/A	
	3	3	N/A	
	4	4	N/A	
	5	5	N/A	
	6	6	N/A	
	7	7	N/A	
	8	8	N/A	
	9	9	N/A	
	- (MINUS)	–	N/A	
	. (dec point)	.	N/A	
27	CLEAR Entry	N/A	CLEAR ENR table	CT
28	ENTER	ET,MZ,DB,DG	N/A	
29	SEQuence	N/A	SET SEQUENCE	N/A
30	STORE	N/A	N/A	
31	RECALL	N/A	N/A	
32	FIXED FREQ	FF	Manual STEP SIZE	N/A
33	Increment	N/A	EXT LO AMPLITUDE	N/A
34	Decrement	N/A	SECOND LO FREQ	SL
35	UPPER LIMIT NOISE	UN	UPPER LIMIT GAIN	UG
36	LOWER LIMIT NOISE	LN	LOWER LIMIT GAIN	LG
37	START FREQ	FA	IF FREQ	IF
38	STOP FREQ	FB	LO FREQ	LO
39	SWEEP AUTO	SR	SWEEP SINGLE	SG
39	Toggle SWEEP Off	SN	N/A	
40	STEP SIZE	SS	N/A	

*DC = Device Clear. SDC = Selective Device Clear. Refer to the manual for the controller to see how to do this.

"Key #" is the number of the key on the front panel per Figure 3-1 and Table 3-1.

4-10. DATA MESSAGES

These messages consist of data which is the result of a measurement performed by the 2075. These messages are sent by the 2075 to the active listener on the bus. The 2075 can send data messages in Normal TALKER/LISTENER or TALK ONLY (TALK ALWAYS) mode.

A measurement message can consist of the data from Window A (the Frequency display), Window B (the Gain display), and Window C (the Noise Figure display). The user selects which data is to be output to the GPIB by setting Special Function 49. The possible choices are shown below:

Table 4-5. Selection of Data Message Contents

DATA OUTPUT TO GPIB	SPECIAL FUNCTION CODE	GPIB CODE
Output Window C data only	49.0	F0
Output Window B data only	49.1	F1
Output Window A data only	49.2	F2
Output Windows A and B data	49.3	F3
Output Windows A and C data	49.4	F4
Output Windows B and C data	49.5	F5
Output Windows A, B, and C data	49.6	F6

Outputting Data Messages in TALK ONLY Mode

The TALK ONLY (TALK ALWAYS) mode is used specifically to allow the 2075 to send its data to a GPIB compatible printer when there is no external controller and when there is no external local oscillator being controlled by the 2075. When in this mode, the 2075 can be configured to output data at the completion of each measurement cycle or to output data only during a Single Swept measurement. It can also be configured to send Second Stage Calibration data.

Use this procedure to output data at the end of each measurement cycle when in the TALK ONLY mode:

1. Select the data message content by entering the appropriate subordinate function of Special Function 49. For example, to select "Output of data from Windows A, B, and C", press:

   SPEC FUNC 49.6 ENTER

2. Set the printer to LISTEN ONLY (LISTEN ALWAYS) mode.
3. Set the 2075 to TALK ONLY mode by pressing:

   SPEC FUNC 40.1 ENTER

The 2075 will send measurement data out to the printer at the end of each measurement cycle until it is reset by entering Special Function 40.0. If the printer is not ready to receive the data, the 2075 will pause and wait until the data is received. Then it will go on to make its next measurement cycle.

If continuous output to the printer is not desired, the 2075 can be configured to output data only during a single sweep by performing the following procedure:

1. Select the data message content by entering the appropriate subordinate function of Special Function 49. For example, to select, "Output of data from Windows A and B", press:

   SPEC FUNC 49.3 ENTER

2. Set the printer to LISTEN ONLY (LISTEN ALWAYS) mode.
3. Set the 2075 to TALK ONLY mode by pressing:

   SPEC FUNC 40.1 ENTER

4. Initiate a single sweep by pressing:

   SHIFT SWEEP

The 2075 will output data to the printer only during the time period of the single sweep.

Note that if the Start and Stop frequencies are made the same, the instrument will output one set of data to the printer when a single sweep is initiated.

To configure the 2075 to send Second Stage Calibration data, use the following procedure:

1. Select the data message content by entering the appropriate subordinate function of Special Function 49. For example, to select, "Output of data from Windows A, B, and C", press:

   SPEC FUNC | 49.6 | ENTER

2. Set the printer to LISTEN ONLY (LISTEN ALWAYS) mode.

3. Enable the HOLD function by pressing:

   SPEC FUNC | 14.1 | ENTER

4. Set the 2075 to TALK ONLY mode by pressing:

   SPEC FUNC | 40.1 | ENTER

5. To perform the calibration and output the data to the printer, press:

   CALIB

The 2075 will output data to the printer only during the calibration. Where Special Function 49.6 has been entered to choose data from Windows A, B, and C, the printer will print out the frequency, calibration step number, and the noise figure. An example of this output is shown in Figure 4-2.

Calibration Step

Frequency

Second Stage Noise Figure

```
100,CAL1, 4.93
150,CAL1, 5.38
200,CAL1, 5.33
250,CAL1, 5.43
300,CAL1, 5.67
350,CAL1, 5.84
400,CAL1, 5.74
450,CAL1, 5.81
500,CAL1, 6.07
100,CAL2, 8.82
150,CAL2,10.20
200,CAL2, 9.89
250,CAL2, 9.72
300,CAL2,10.27
350,CAL2,10.93
400,CAL2,10.41
450,CAL2,11.49
500,CAL2,11.83
100,CAL3,22.75
150,CAL3,24.03
200,CAL3,23.74
250,CAL3,23.64
300,CAL3,23.96
350,CAL3,25.39
400,CAL3,24.40
450,CAL3,25.67
500,CAL3,25.77
```

CALIBRATION DATA

Frequency Gain Noise Figure

```
100, -0.03,-0.06
150, -0.03,-0.01
200, -0.04,-0.01
250, -0.04, 0.02
300, -0.04,-0.03
350, -0.02,-0.13
400, -0.03,-0.06
450, -0.05, 0.07
500, -0.03, 0.01
```

MEASUREMENT DATA

Figure 4-2. SAMPLE DATA OUTPUT

Outputting Data Messages in Normal TALKER/LISTENER Mode

The Normal TALKER/LISTENER mode is the GPIB operating mode in which the 2075 is controlled by an external controller or computer. In this mode, for data messages to be output to a listener device, the controller performs two steps:

1. The controller sends an ADDRESS TO LISTEN command to the device that will receive the data messages.
2. The controller sends an ADDRESS TO TALK command to the 2075. Then the data message transmission occurs as would any normal data exchange.

To configure the 2075 to send data messages while in this mode, use the following steps:

1. Set the 2075 to Normal TALKER/LISTENER mode by pressing:

   SPEC FUNC 40.0 ENTER

   This step is not necessary if the 2075 has just been powered-on because 40.0 is the default mode after power-on.

2. Send the necessary GPIB codes (device messages) to the 2075 to configure it for the desired measurement. Refer to paragraph 4-9 and Tables 4-3 and 4-4.
3. Send the appropriate GPIB code (F0 through F6) to select the desired format and contents of the data messages. Refer to Table 4-3.
4. Determine the correct program statement needed by the controller to receive data from the 2075.
5. After the data is received, unaddress the 2075. If this is not done, it will remain in the active talker state and repeatedly try to output data to the bus after each measurement cycle.

The following program example illustrates the correct procedure using an HP 85 controller programmed in BASIC. The 2075 address is 8 and it is tuned to 100 MHz. Special Function 40.0 is already in effect.

```
100 OUTPUT 708 ;"F0"   (Send F0 for output
                        from Window C only)
110 ENTER 708 ; N      (Enter 708 - 1 message)
120 SEND 7 ; UNT       (Untalk)
```

The above 3 lines correspond to steps 3, 4, and 5 of the preceding procedure.

Data Message Format

Data messages are sent either as single messages (Special Functions 49.0, 49.1 or 49.2) or as multiple messages (Special Functions 49.3, 49.4, 49.5, or 49.6). The format for single messages is slightly different from that for multiple messages. A multiple message may have a separator between each single message in the group and uses a line terminator only at the end of the group. A single message has no separators but is also ended with a line terminator.

Single messages (GPIB codes F0, F1, or F2) are formatted as follows:

	Data	Line Terminator
Example:	5.65	[CR] [LF]

Note that the line terminator for the message is Carriage Return/Line Feed.

A multiple message (GPIB codes F3, F4, F5, or F6) is formatted as follows:

	Data	Separator	Data	Separator
Example:	10	,	45.23	,
	Data	**Line Terminator**		
	4.75	[CR] [LF]		

Note that the separator in the above example is a comma. The line terminator is Carriage Return/Line Feed. These are generated by the 2075. The terms are explained below.

Data is the numeric value in scaled decimal format with a fixed decimal point and no exponents. The units of measurement are implied by the current settings of the 2075. Frequency is always MHz, Gain or Noise Figure is dB or Ratio as previously selected, T_e is kelvins, and Y-Factor is dB or Ratio.

The Line Terminator is the delimiter used to indicate the end of a message. It is the Carriage Return/Line Feed sequence sent with the EOI line set TRUE.

The Separator is used to separate the individual data messages within the multiple message. Any ASCII character or string of characters can be selected to be the separator. This allows the normal comma (default) separator to be replaced to meet the requirements of any type of controller. If the data output is to a printer, for example, it would be convenient to define the separator as a string of spaces.

The program message ' ' (apostrophe/space/apostrophe) defines a space as the separator. The program message '##' would define two ##'s as the separator. It should be noted that some controllers accept only a comma as a data separator. Insure that any other separator which may be used is acceptable to the controller.

Error Messages

In situations where the measured data is invalid, the data message will contain an error message. The general form of the error message is XXXE10. The controller may change the form to X.XXE10. In some cases this type of message may be used as an end code.

Some examples of data messages which contain error messages are:

100,1.71+E10,5.55	The error message is Error 171 (Data not available for Gain)
350,1.70+E10,5.4	The error message is Error 170 (Measured data out of range)

Refer to Table 3-10 for a complete listing of error messages.

4-11. STATUS MESSAGES

Status messages are sent to the controller in the form of a Status Byte. The sequence of events is:

1. Some device on the bus initiates a Service Request by setting the SRQ (Service Request) line to TRUE.
2. The controller conducts a serial poll by having each device on the bus send a Status Byte. The controller reads each Status Byte to determine what device initiated the Service Request and why the device needs servicing.
3. The controller goes into a subroutine to service the device.

Service Request Message

When the 2075 requires service it sends the Service Request message to the controller by setting the SRQ line to TRUE. A special function determines what condition will cause the 2075 to request service from the controller. The table shown below lists the special function codes which determine what condition will cause the 2075 to request service. These special functions are mutually exclusive, that is, only one should be selected.

SPECIAL FUNCTION	GPIB CODES	CONDITION CAUSING SRQ
42.0	NI	All SRQ's are disabled
42.1	RA	SRQ on DATA READY
43.0	SRQ	Disable
43.1	RC	SRQ on CALIBRATION COMPLETE
45.0	SRQ	Disable
45.1	RT	SRQ on READY TO TUNE
46.0	SRQ	Disable
46.1	RI	SRQ on INSTRUMENT ERROR

The 2075 will not generate an SRQ unless one of these has been selected. To select one of these, send the appropriate GPIB code to the 2075. To disable, set the special function to its .0 value or send the equivalent GPIB code. It is recommended that the 2075 be placed in HOLD (GPIB code: T1) prior to enabling an SRQ condition. This will prevent the 2075 from sending an SRQ before the controller is ready to handle it. After the SRQ condition has been enabled, send the GPIB code T0 to return the 2075 to continuous measurement cycle.

Status Byte

When the 2075 requires the attention of the controller it sets the SRQ line TRUE. The controller then conducts a serial poll and reads the Status Byte from each device on the bus. After reading all the Status Bytes, the controller knows what device set the SRQ line TRUE, and what condition in that device requires servicing.

The format of the Status Byte of the 2075 is shown:

The appropriate bits are set to 1 when the condition is TRUE.

After the status message (Status Byte) has been sent it will be cleared if the 2075 receives one of the following messages from the controller:

SERIAL POLL DISABLE
ABORT
CLEAR

The flowchart of Figure 4-4 shows how data is collected using the Data Ready SRQ in Test Configuration 1.

Figure 4-5 is a sample program used for data collection in Test Configuration 1 with SRQ on Data Ready and an HP 85 as the system controller.

Figure 4-6 gives an example of measurement results obtained from running the program in Figure 4-5.

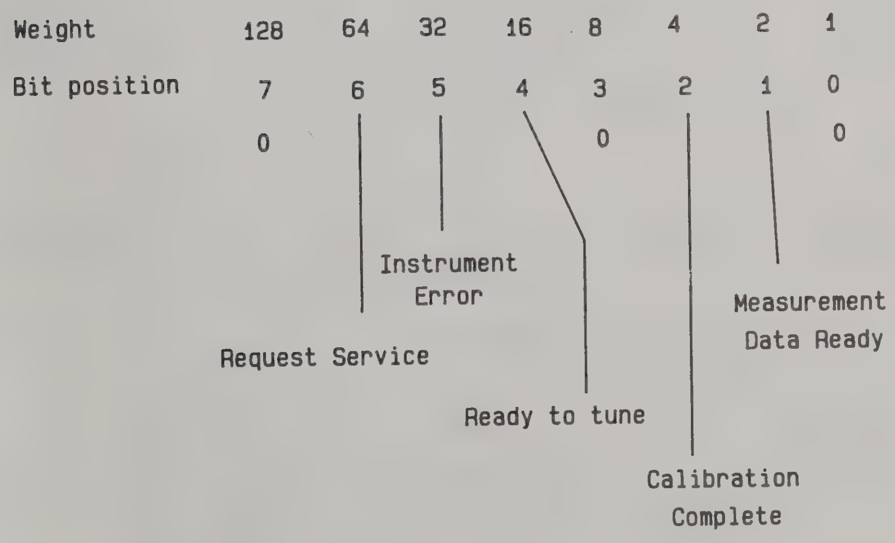


Figure 4-3. STATUS BYTE

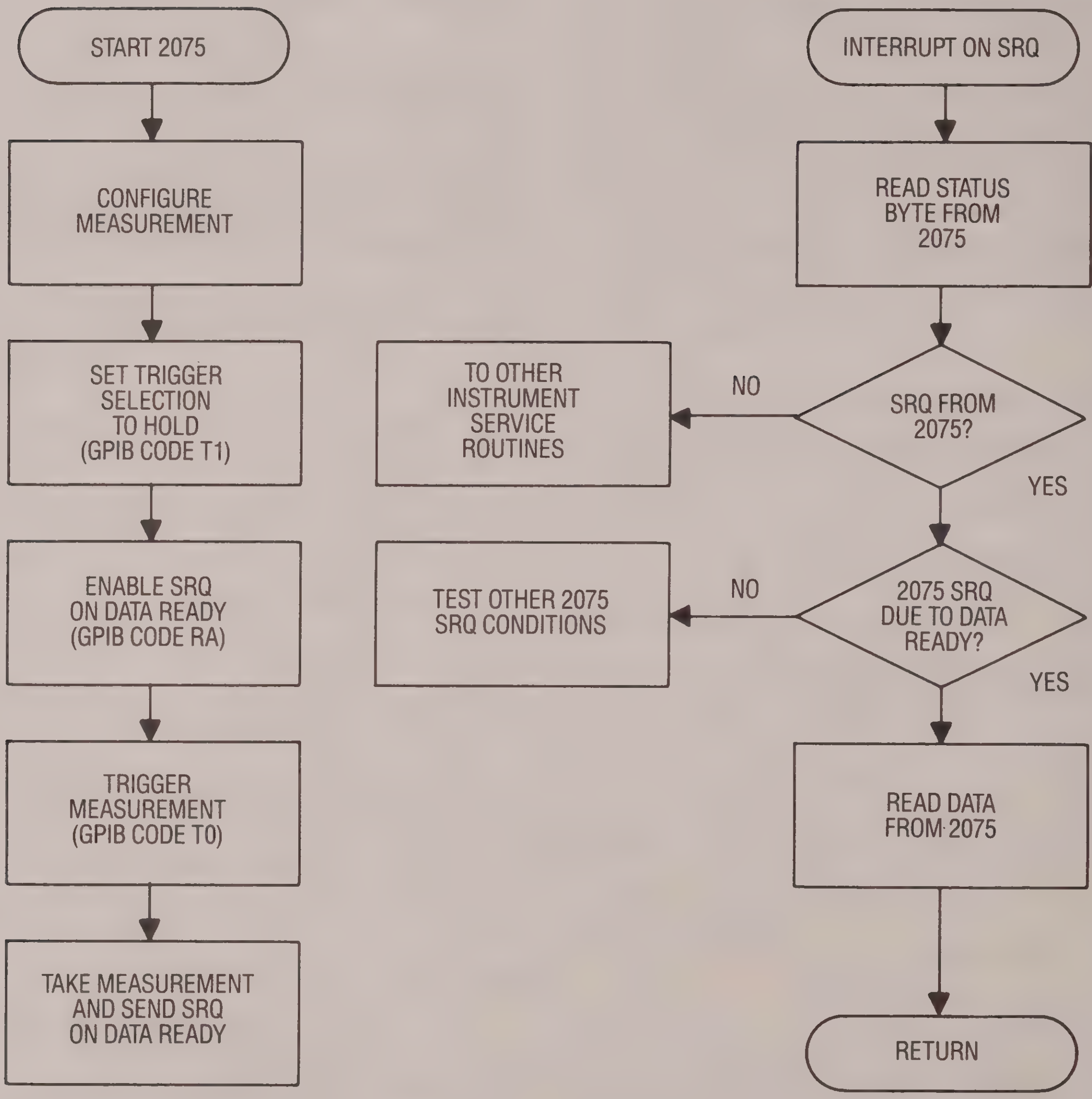

START 2075
CONFIGURE MEASUREMENT
SET TRIGGER SELECTION TO HOLD (GPIB CODE T1)
ENABLE SRQ ON DATA READY (GPIB CODE RA)
TRIGGER MEASUREMENT (GPIB CODE T0)
TAKE MEASUREMENT AND SEND SRQ ON DATA READY
INTERRUPT ON SRQ
READ STATUS BYTE FROM 2075
SRQ FROM 2075?
NO
TO OTHER INSTRUMENT SERVICE ROUTINES
YES
2075 SRQ DUE TO DATA READY?
NO
TEST OTHER 2075 SRQ CONDITIONS
YES
READ DATA FROM 2075
RETURN

Figure 4-4. FLOWCHART SHOWING DATA COLLECTION IN TEST CONFIGURATION 1 USING DATA READY SRQ

```
 10 !  PROGRAM TO DEMO SRQ
 20 !  ON DATA READY
 30 !  TRIGGED MEASUREMENT
 40 !
 50 !
 60 !  NORMAL NOISE MEASUREMENT
 70 !  FREQENCY OF MEAS 500 MHZ
 75 !  AND 600 MHZ
 80 !  SMOOTHING = 32
 90 !  DISPLAYS A AND C READ
100 !  PRINT DATA TO THERM PRT
110 !
120 ! FIRST STEP:
130 ! SET UP INTERRUPT
140 ! INITIALIZE OF HP 85
150 ON INTR 7 GOSUB 1000
160 ENABLE INTR 7;8
170 !
180 ! SECOND STEP:
190 ! COFIGURE 2075 MEASUREMENT
200 !
210 ! TUNE TO 500 MHZ
220 OUTPUT 708 ;"FR 500 MZ"
230 !
240 ! SET SMOOTHING FACTOR
250 !
260 OUTPUT 708 ;"S5"
270 !
280 ! MEASURE NOISE FIGURE

290 OUTPUT 708 ;"NF"
300 !
310 ! SET DATA OUTPUT FORMAT
320 !
330 OUTPUT 708 ;"F4"
340 ! SEND TRIGGER CODE(HOLD)
350 !
360 OUTPUT 708 ;"T1"
370 !
380 !
390 ! WE ARE NOW READY TO MAKE
400 ! OUR MEASUREMENTS
410 !
420 ! STEP 3 SEND SRQ ON DATA RD
    Y430 !
430 !
440 OUTPUT 708 ;"RA"
450 !
460 ! SEND TRRIGGER MESSAGE
470 ! AND PROCESS OTHER ROUTINES
480 ! UNTILL SRQ CAUSES INTERUPT
490 OUTPUT 708 ;"T0"
495 T=1
500 IF T<3 THEN GOTO 500
510 END
```

Figure 4-5. PROGRAMMING EXAMPLE FOR DATA COLLECTION IN TEST CONFIGURATION 1 USING SRQ ON DATA READY WITH HP85 CONTROLLER

```
520 !
530 !
540 !
900 ! SRQ SERVICE ROUTINES
910 ! IF SRQ THEN:
920 ! WHO SENT SRQ ?
930 ! WHY WAS SRQ SENT?
940 ! PROCESS INFOMATION AS
950 ! NECESSARY
960 !
970 !
980 ! STEP 1: WHO SENT SRQ
990 ! DO SERIAL POLL
1000 S=SPOLL(708)
1010 IF BIT(S,6)=1 THEN GOTO 200
     0
1020 ! ELSE POLL OTHER DEVICES
1030 ! ON BUSS
1040 GOTO 6050
2000 PRINT "2075 SENT SRQ"
2010 PRINT "TESTING CAUSE"
2020 IF BIT(S,1)=1 THEN GOTO 300
     0
2030 ! TEST OTHER BITS FOR
2040 ! OTHER POSSIBLE SRQ
2050 ! CAUSES
3000 PRINT "2075 SENT DATA READY
      SRQ"
3010 PRINT "READING 2075 DATA"
3020 ENTER 708 ; F,N
3030 SEND 7 ; UNT
3032 ! DISABLE DATA RDY SRQ
3034 OUTPUT 708 ;"NI"
3040 PRINT "DATA RECORD"
3050 PRINT "FREQ=",F
3060 PRINT "NOISE FIG=",N
3080 ! INITIALIZE HP 85 STATUS
3090 STATUS 7,1 ; S1
4000 ENABLE INTR 7;8
4010 IF T=1 THEN GOTO 6000
5000 IF T=2 THEN GOTO 6030
6000 ! TUNE TO NEXT FREQ AND
6010 ! RE ENABLE SRQ ON DATA
6020 ! READY
6030 T=T+1
6032 IF T=3 THEN GOTO 6050
6035 OUTPUT 708 ;"FR 600 MZ"
6040 IF T=2 THEN OUTPUT 708 ;"RA
     "
6050 RETURN
```

Figure 4-5. PROGRAMMING EXAMPLE FOR DATA COLLECTION IN TEST CONFIGURATION 1 USING SRQ ON DATA READY WITH HP85 CONTROLLER (Continued)

```
2075 SENT SRQ
TESTING CAUSE
2075 SENT DATA READY SRQ
READING 2075 DATA
DATA RECORD
FREQ=                         500
NOISE FIG=                    6.06
2075 SENT SRQ
TESTING CAUSE
2075 SENT DATA READY SRQ
READING 2075 DATA
DATA RECORD
FREQ=                         600
NOISE FIG=                    6.38
```

Figure 4-6. SAMPLE RESULTS FROM RUNNING PROGRAM IN FIGURE 4-5

Synchronizing the Controller and the External Local Oscillator

When an external controller is used to control the 2075 and the external local oscillator tuning, as may be done in Test Configurations 2, 4, and 6, it is necessary to synchronize the controller with the measurement cycle of the 2075. This synchronization is accomplished by the structure of the controller program, and varies according to the type of SRQ being used. Using Special Functions 42.0 through 46.0, the 2075 can be configured to initiate an SRQ on Data Ready, Calibration Complete, or Ready to Tune. The following information shows how the program must be structured to achieve sychronization when the 2075 is configured for SRQ on Ready to Tune. Following that, information is given to show the correct program structure when the 2075 is configured for SRQ on Data Ready.

Figure 4-7 shows a typical swept measurement setup for Test Configuration 2.

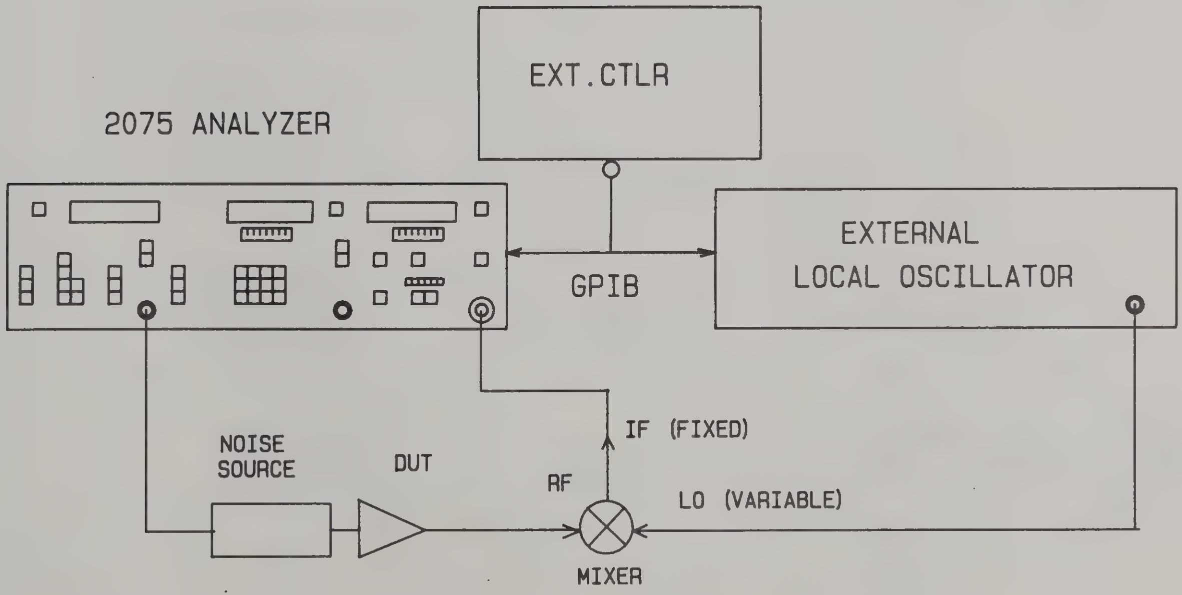


Figure 4-7. SETUP IN TEST CONFIGURATION 2

The following steps illustrate the general form of the controller program when the 2075 is configured to initiate an SRQ on Ready to Tune. (SRQ on Ready to Tune means that the 2075 will send a service request to the controller when the 2075 is ready to tune to the next frequency step of a sweep.) This form is also shown in the flowchart of Figure 4-8.

General form of the controller program for SRQ on Ready to Tune is:

1. Place the 2075 in HOLD mode (T1).
2. Send all parameters required to do the measurement to the 2075.
3. Send the required settling time (T settle) to the 2075. T settle should be equal to the local oscillator settling time (the time required for the LO to settle after tuning to a new frequency) plus any overhead time taken by the controller to set up the external local oscillator frequency. It is a good idea to include some extra time in T settle to allow some margin.
4. Send the code that configures the 2075 for SRQ on Ready to Tune (RT).
5. Send the single sweep command to the 2075.
6. If sweep is not completed, wait for the SRQ from the 2075.
7. Upon receiving the SRQ, read the Status Byte of the 2075. If Bit 4 of the Status Byte is set to 1, then send the command to tune the external local oscillator to the new frequency. (Any SRQ sets Bit 6 of the Status Byte and the Ready to Tune SRQ also sets Bit 4.)
8. Address the 2075 to Talk and then read the measurement data.
9. If sweep is completed then end. Otherwise, return to step 6.

The main point in the above steps is that after the Status Byte is read, the 2075 will wait for the amount of time determined by T settle, and then make the next measurement. The flowchart of Figure 4-8 illustrates the correct program structure.

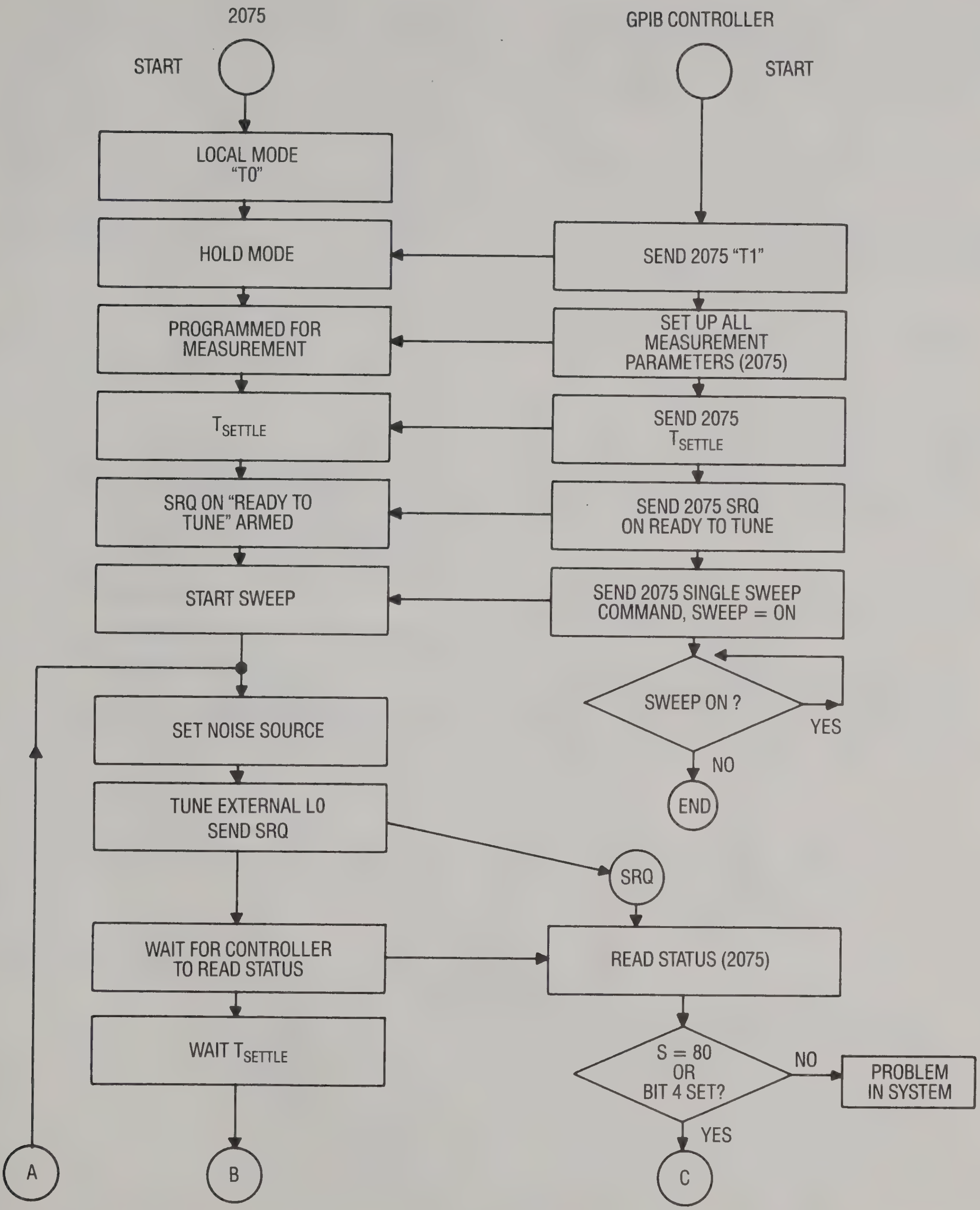

2075
GPIB CONTROLLER
START
START
LOCAL MODE "T0"
HOLD MODE
SEND 2075 "T1"
PROGRAMMED FOR MEASUREMENT
SET UP ALL MEASUREMENT PARAMETERS (2075)
T_SETTLE
SEND 2075 T_SETTLE
SRQ ON "READY TO TUNE" ARMED
SEND 2075 SRQ ON READY TO TUNE
START SWEEP
SEND 2075 SINGLE SWEEP COMMAND, SWEEP = ON
SWEEP ON ?
YES
NO
END
SET NOISE SOURCE
TUNE EXTERNAL LO SEND SRQ
SRQ
WAIT FOR CONTROLLER TO READ STATUS
READ STATUS (2075)
WAIT T_SETTLE
S = 80 OR BIT 4 SET?
NO
PROBLEM IN SYSTEM
YES
A
B
C

Figure 4-8. FLOWCHART FOR SRQ ON READY TO TUNE

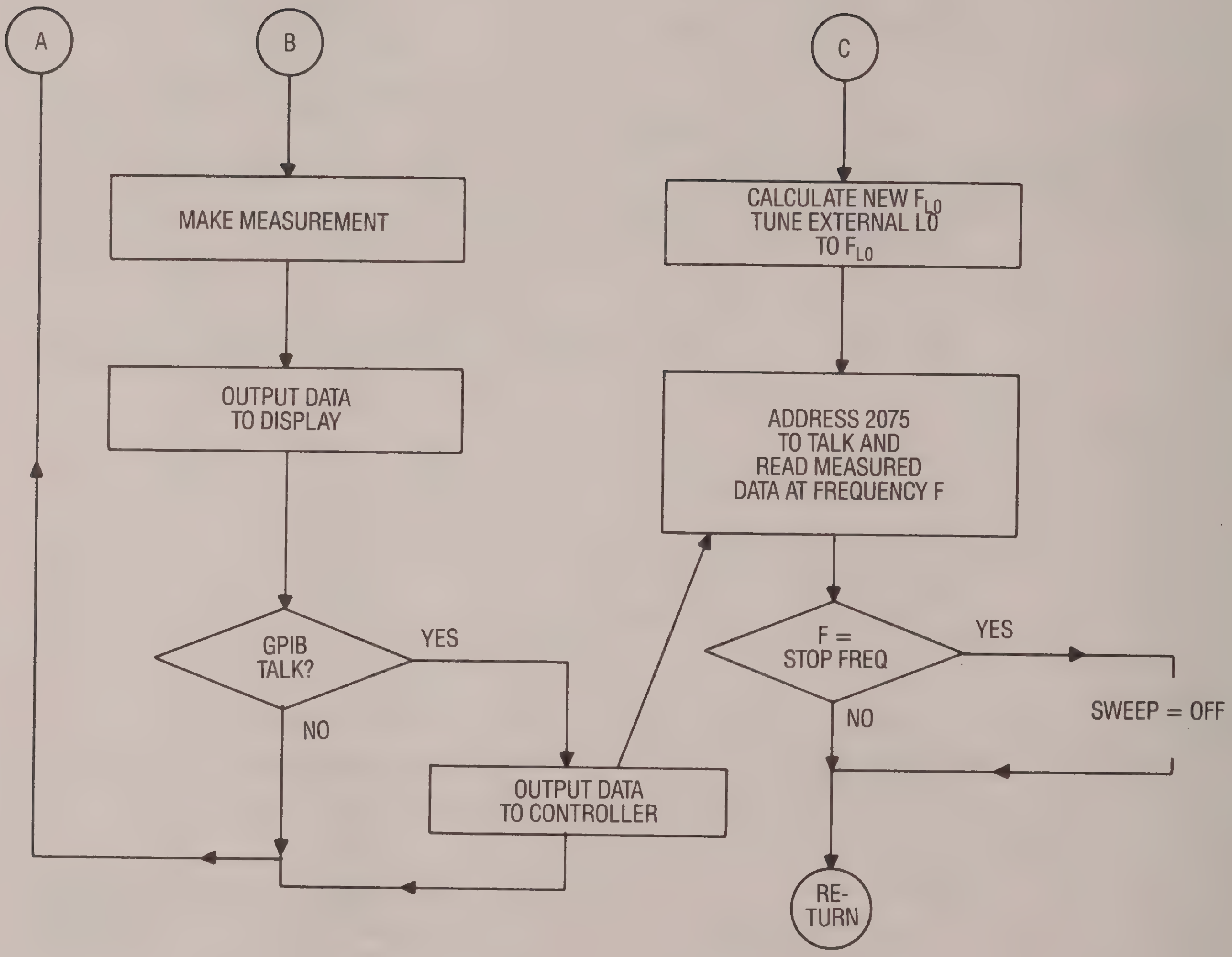

A
B
C
MAKE MEASUREMENT
OUTPUT DATA TO DISPLAY
GPIB TALK?
YES
NO
OUTPUT DATA TO CONTROLLER
CALCULATE NEW F_LO TUNE EXTERNAL LO TO F_LO
ADDRESS 2075 TO TALK AND READ MEASURED DATA AT FREQUENCY F
F = STOP FREQ
YES
NO
SWEEP = OFF
RE-TURN

Figure 4-8. FLOWCHART FOR SRQ ON READY TO TUNE (Continued)

When the 2075 is configured to generate an SRQ on Data Ready, the form of the controller program must be different from the form used with SRQ on Ready to Tune. The following steps show how the program should be structured to achieve the correct synchronization of the controller and the 2075 when using SRQ on Data Ready. (SRQ on Data Ready means that the 2075 will send a service request to the controller when the data from the measurement just made is ready to be transmitted.) This example applies to Test Configurations 2, 4 or 6. An example of Test Configuration 2 is shown in Figure 4-7.

1. Place the 2075 in the HOLD mode (T1).
2. Send all parameters required to do the measurement to the 2075.
3. Send the required settling time (T settle) to the 2075. T settle should be equal to the local oscillator settling time (the time required for the LO to settle after tuning to a new frequency) plus any overhead time taken by the controller to set up the external local oscillator frequency. It is a good idea to include some extra time in T settle to allow some margin.
4. Send the code that configures the 2075 for SRQ on Data Ready (RA).
5. Send the code that tunes the external local oscillator to the sweep start frequency.
6. Send the single sweep command to the 2075.
7. Wait for the SRQ from the 2075.
8. Upon receiving the SRQ, read the Status Byte of the 2075. If Bit 1 of the Status Byte is set to 1, then proceed with the next step. (Any SRQ sets Bit 6 of the Status Byte and the Data Ready SRQ also sets Bit 1.)
9. Send the command to tune the external local oscillator to the next frequency.
10. Address the 2075 to talk and then read the measurement data. The data being read in this step is from the previous measurement that was executed before step 9 was done.
11. If sweep is completed then end. Otherwise, return to step 7.

The main point in the above is that the data from the previous measurement frequency is ready to be read when the 2075 sends the SRQ to the controller. If the controller program does not do step 8 before doing step 9, the controller and the 2075 will go into a race with each other.

The flowchart of Figure 4-9 illustrates the correct program structure to synchronize the controller and the 2075 when using SRQ on Data Ready.

The sample program of Figure 4-10 synchronizes the controller and the 2075 during calibration using the SRQ on Ready to Tune. It synchronizes the two instruments during measurement using the SRQ on Data Ready.

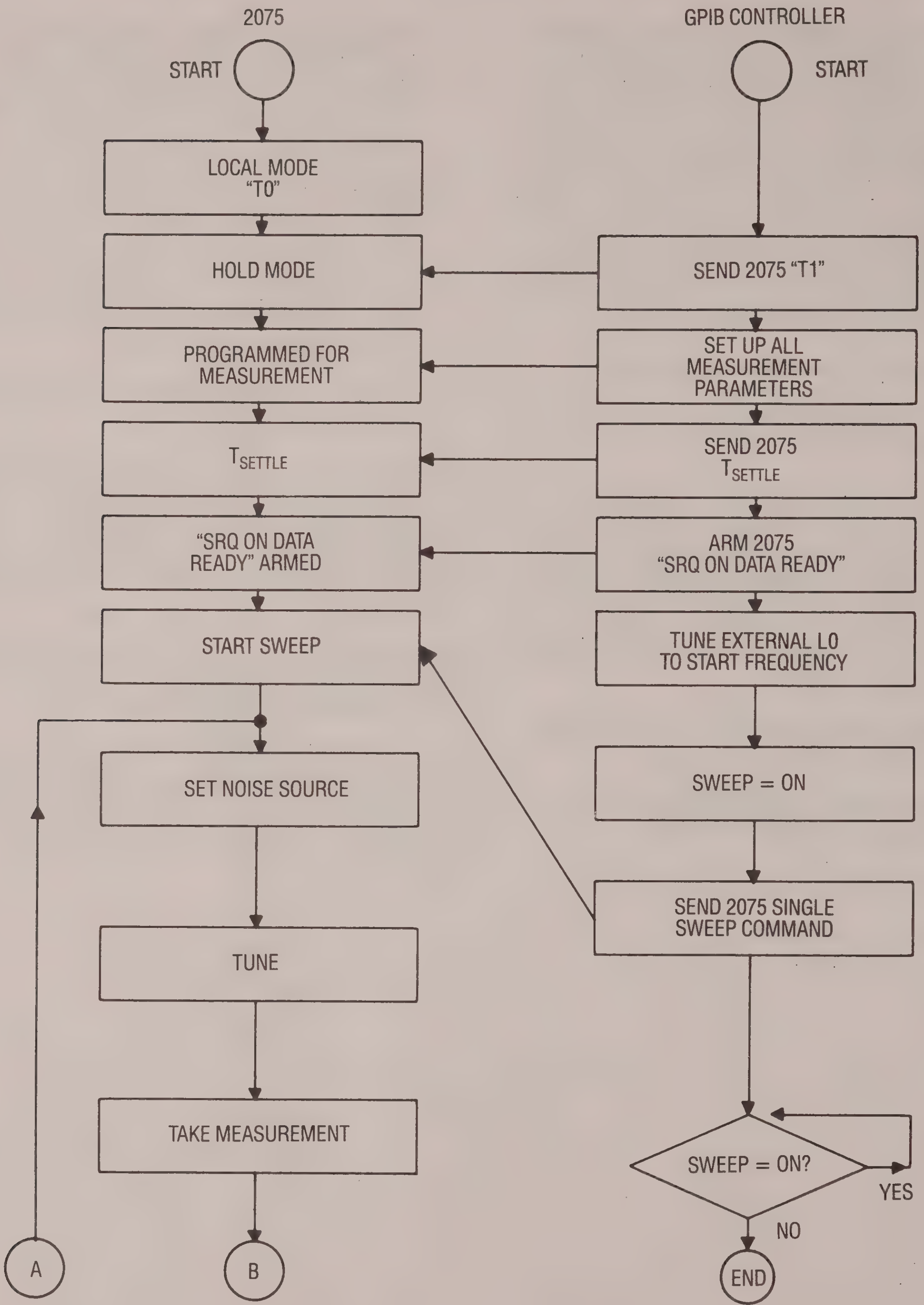

2075
START
LOCAL MODE "T0"
HOLD MODE
PROGRAMMED FOR MEASUREMENT
T_SETTLE
"SRQ ON DATA READY" ARMED
START SWEEP
SET NOISE SOURCE
TUNE
TAKE MEASUREMENT
A
B
GPIB CONTROLLER
START
SEND 2075 "T1"
SET UP ALL MEASUREMENT PARAMETERS
SEND 2075 T_SETTLE
ARM 2075 "SRQ ON DATA READY"
TUNE EXTERNAL LO TO START FREQUENCY
SWEEP = ON
SEND 2075 SINGLE SWEEP COMMAND
SWEEP = ON?
YES
NO
END

Figure 4-9. FLOWCHART FOR SRQ ON DATA READY

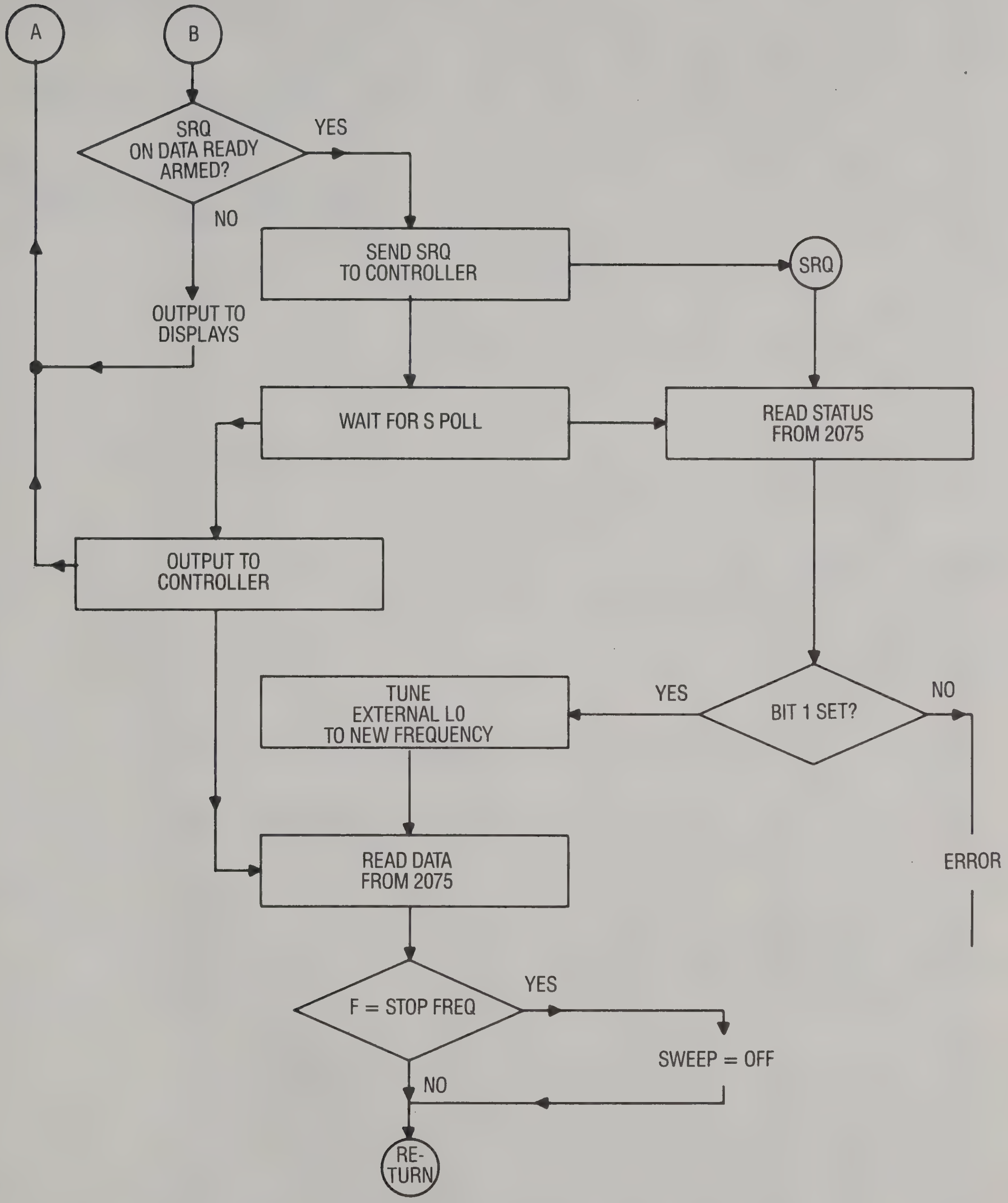


Figure 4-9. FLOWCHART FOR SRQ ON DATA READY (Continued)

This program uses Test Configuration 2 - Double Sideband. The Controller is on HP 85 and the External Local Oscillator is a Wiltron 6600 series sweep generator.

During Calibration, the Controller synchronizes the L.O. tuning and the 2075 using the READY TO TUNE SRQ interrupt (RA).

During measurement the Controller synchronizes the L.O. tuning and the 2075 using the DATA READY SRQ interrupt (RT).

```
 10 DISP "THIS IS THE MEASUREMEN
    T PROGRAM"
 20 DISP "FOR A MICROWAVE AMPLIF
    IER USING"
 30 DISP "THE SWEPT LO, DSB TECH
    NIQUE"
 40 DISP @ DISP "SET THE 2075 BU
    S ADDRESS TO 8"
 50 DISP @ DISP "SET THE 6600 BU
    S ADDRESS TO 19"
 60 DISP @ DISP "PRESS K4, 'CONT
    ' WHEN READY"
 70 ON KEY# 4,"CONT" GOTO 100
 80 KEY LABEL
 90 GOTO 90
```

```
100 CLEAR @ BEEP
110 DISP "START FREQUENCY(MHZ)="
    ;
120 INPUT F1
130 DISP @ DISP "STOP FREQUENCY(
    MHZ)=";
140 INPUT F2
150 DISP @ DISP "STEP SIZE(MHZ)=
    ";
160 INPUT F0
170 DISP @ DISP "IF (MHZ)=";
180 INPUT I
190 DISP @ DISP "LO POWER(DBM)="
    ;
200 INPUT P0
210 IF P0>10 THEN 270
220 DISP @ DISP "SMOOTHING INCRE
    MENT=";
230 INPUT E
```

User enters measurement parameters.

```
240 GOSUB 300
250 GOSUB 500
260 GOTO 570
270 CLEAR @ BEEP
280 DISP "MAX LO POWER IS +10DBM
    "
```

Depends on L.O. used

```
290 GOTO 190
300 S=SPOLL(708)
```

Clear 2075 Status Register (optional here)

```
310 OUTPUT 708 ;"NI,T1,LE,NF,F6,
    D2,A0,N0,P2,B1,RF,C1,NS,GF,D
    F"
320 OUTPUT 708 ;"FA";F1;"MZ"
330 OUTPUT 708 ;"FB";F2;"MZ"
340 OUTPUT 708 ;"SS";F0;"MZ"
350 OUTPUT 708 ;"IF";I;"MZ"
360 OUTPUT 708 ;"ST50ET"
370 IF E=0 THEN E$="S0"
380 IF E=1 THEN E$="S1"
390 IF E=2 THEN E$="S2"
400 IF E=3 THEN E$="S3"
410 IF E=4 THEN E$="S4"
420 IF E=5 THEN E$="S5"
430 IF E=6 THEN E$="S6"
440 IF E=7 THEN E$="S7"
450 IF E=8 THEN E$="S8"
460 IF E=9 THEN E$="S9"
470 OUTPUT 708 ;E$
480 OUTPUT 708 ;"T0"
490 RETURN
```

Set up the 2075

Figure 4-10. SAMPLE PROGRAM

```
500 OUTPUT 719 ;"RF0,IL1,FM0,MK0"
510 F=F1
520 OUTPUT 719 ;"CF0"
530 OUTPUT 719 ;"F0";F;"MH"
540 OUTPUT 719 ;"LVL";P0;"DM"
550 OUTPUT 719 ;"RF1"
```

Set up the L.O.

```
560 RETURN
570 F=F1 @ C=1
580 STATUS 7,1 ; S
```

Clear HP 85 Status Register

```
590 ENABLE INTR 7;8
600 ON INTR 7 GOTO 720
610 CLEAR @ BEEP
620 DISP "CONNECT THE NOISE GENE
    RATOR TO"
630 DISP "THE MIXER INPUT"
640 DISP @ DISP "PRESS k4,'CONT'
     WHEN READY"
650 ON KEY# 4,"CONT" GOTO 680
660 KEY LABEL
670 GOTO 670
680 CLEAR @ DISP @ DISP @ DISP @
     DISP
690 DISP "*2nd STAGE NOISE CAL I
    N PROGRESS"
700 OUTPUT 708 ;"RT,CA"
```

Enable READY TO TUNE SRQ and begin Calibration

```
710 GOTO 710
720 S=SPOLL(708)
730 IF BIT(S,4)=0 THEN GOTO 820
```

READY TO TUNE SRQ sets bit 4 of the status register

```
740 OUTPUT 719 ;"CF0,F0";F;"MH"
750 F=F+F0
760 IF F=F2+F0 THEN C=C+1 @ F=F1
```

"C" is a pointer which keeps track of which RF attentuator state is being calibrated.
(Alternately, could enable (RC) which sends SRQ interrupt when Calibration is complete. Sets bit 2 of the status register)

```
770 IF F>F2 THEN F=F2
780 IF C=4 THEN GOTO 880
790 STATUS 7,1 ; S
800 ENABLE INTR 7;8
810 GOTO 810
820 CLEAR @ BEEP
830 DISP "NO SRQ"
840 DISP "SOMETHING SCREWED UP"
850 DISP "CHECK CABLES,ADDRESS,E
    TC."
860 DISP @ DISP "PRESS k4, 'CONT
    ' TO RESTART"
870 ON KEY# 4,"CONT" GOTO 10
```

Error routine

```
880 CLEAR @ BEEP
890 DISP "*2nd STAGE CAL COMPLETE"
900 WAIT 1000
910 OUTPUT 708 ;"NI"
```

Disable SRQ's

```
920 S=SPOLL(708)
```

Clear 2075 status register (optional here)

```
930 F=F1
```

Prepare for measurement

```
940 OUTPUT 719 ;"CF0,F0";F;"MH"
950 DISP @ DISP "CONNECT THE DUT
     BETWEEN THE"
960 DISP "NOISE GENERATOR AND TH
    E MIXER"
970 DISP @ DISP "PRESS k4,'CONT'
     WHEN READY"
980 ON KEY# 4,"CONT" GOTO 1010
990 KEY LABEL
1000 GOTO 1000
1010 PRINT @ PRINT @ CLEAR
1020 PRINT "    ** AMPLIFIER TES
     T DATA  **"
```

Figure 4-10. SAMPLE PROGRAM (Continued)

```
1030 PRINT @ PRINT "FREQ
      GAIN       NOISE FIG"
1040 PRINT "(Mhz)          (dB)
           (dB)"
1050 F=F1
1060 OUTPUT 719 ;"CF0,F0";F;"MH"
1070 STATUS 7,1 ; S
1080 ON INTR 7 GOTO 1120
1090 ENABLE INTR 7;8
1100 OUTPUT 708 ;"T1,RA,SG"
1110 GOTO 1110
1120 S=SPOLL(708)
1130 IF BIT(S,1)=0 THEN GOTO 820
1140 F=F+F0
1150 IF F>F2 THEN F=F2
1160 OUTPUT 719 ;"CF0,F0";F;"MH"
1170 WAIT 50
1180 ENTER 708 ; X,Y,Z
1190 SEND 7 ; UNT
1200 IMAGE 5D,7X,M2D.2D,9X,2D.2D
1210 PRINT USING 1200 ; X,Y,Z
1220 IF F=F2+F0 OR X=F2 THEN GOT
     O 1260
1230 STATUS 7,1 ; S
1240 ENABLE INTR 7;8
1250 GOTO 1250
1260 OUTPUT 708 ;"NI,NG,T0"
1270 PRINT @ PRINT @ PRINT @ PRI
     NT @ PRINT @ PRINT
1280 OFF KEY# 4
1290 CLEAR @ BEEP
1300 DISP "TEST COMPLETE"
1310 DISP "PRESS THE APPROPRIATE
      KEY BELOW"
1320 DISP "FOR NEXT ACTION"
1330 DISP
1340 DISP "k1";TAB(10);"REPEAT T
     EST"
1350 DISP "k2";TAB(10);"RECAL 2n
     D STAGE"
1360 DISP "k3";TAB(10);"NEW TEST
     "
1370 DISP "k4";TAB(10);"END TEST
     ING"
1380 ON KEY# 1,"REPEAT" GOTO 1440
1390 ON KEY# 2,"RE-CAL" GOTO 1470
1400 ON KEY# 3,"NEW" GOTO 1500
1410 ON KEY# 4,"END" GOTO 1530
1420 KEY LABEL
1430 GOTO 1430
1440 OFF KEY# 1 @ OFF KEY# 2 @ O
     FF KEY# 3 @ OFF KEY# 4
1450 CLEAR @ BEEP
1460 GOTO 950
1470 OFF KEY# 1 @ OFF KEY# 2 @ O
     FF KEY# 3 @ OFF KEY# 4
1480 CLEAR @ BEEP
1490 GOTO 570
1500 OFF KEY# 1 @ OFF KEY# 2 @ O
     FF KEY# 3 @ OFF KEY# 4
1510 CLEAR @ BEEP
1520 GOTO 100
1530 END
```

Clear Controller Status Register

Enable DATA READY SRQ. Single Sweep allowed in measurement hold mode.

Data Ready sets bit 1 of 2075 Status Register

Update L.O. frequency before reading data from 2075. 2075 will not make another measurement until data has been read.

Tell 2075 to stop sending data.

Figure 4-10. SAMPLE PROGRAM (Continued)

SECTION 5

PERFORMANCE VERIFICATION TESTS

5-1. INTRODUCTION

This section of the manual contains Performance Verification Tests which are used to verify that the 2075 is functioning in accordance with the specification requirements listed in Section 1. These procedures are normally performed upon receipt of the instrument, after repair or adjustment, or when the performance of the 2075 is suspect. These procedures should also be performed every six months to verify the continued optimum performance of the 2075.

5-2. TEST EQUIPMENT REQUIRED

The test equipment required for conducting the performance verification tests is listed in Table 5-1. For each item listed, the recommended manufacturer and model number is shown where appropriate. Minimum or critical parameters are also shown. Generally, it is desirable to use equipment with an accuracy four times greater than the parameter being tested. However, for the most part, these tests are internal checks performed by the 2075 and, therefore, accuracy of other test equipment is not important except for the Digital Voltmeter.

Test equipment warm-up is not critical for the first tests in this group. However, the 2075 should be warmed-up for at least 10 minutes before performing the Final Detector Linearity Test.

Table 5-1. Test Equipment Requirements for Performance Verification Testing

INSTRUMENT	MINIMUM PARAMETERS	RECOMMENDED MODEL
Digital Voltmeter	5½ digits	Fluke 8840A
Dual Channel Oscilloscope	Z-Axis blanking on positive-going TTL input	Tektronix 2213A
Calibrated Noise Source		EATON 7618E or 7626
Test Cables with BNC Connectors		

5-3. PERFORMANCE VERIFICATION PROCEDURES

The Performance Verification Procedures are listed in Table 5-2. It is recommended that they be performed in the sequence listed. Access to the interior of the 2075 is not required for performance of these procedures. All tests are to be done at room temperature.

Table 5-2. Performance Verification Tests

PROCEDURE	PARAMETER OR FUNCTION VERIFIED
Power-on Test	Self-Test Functions
Noise Drive Voltage Test	Noise Drive Voltage Level
IF Attenuators Calibration	Calibration of IF Attenuators
Final Detector Bias Test	Bias Voltage Level
Second Stage Calibration	Noise Figure versus Calibration Steps
Final Detector Linearity Test	Detector Linearity

5-4. POWER-ON TEST

This is a series of internal self-checks performed by the 2075 upon power-up. The unit checks the operation of its Math Processor, RAM, ROM, GPIB Controller, and its DMAC (Direct Memory Access Controller). Finally, the 2075 performs an FCAL (Frequency Calibration) to ensure the accuracy of its frequency tuning. No test equipment is required for this procedure.

Perform the following steps:

1. Connect the 2075 to an AC power source of the appropriate voltage.
2. Remove any devices connected to the RF INPUT.
3. Place the POWER switch in the ON position.
4. The following correct indications should be observed:
   a. All front panel red LED's and indicators light briefly.
   b. The words SELF and TEST appear in Windows A and B respectively, while the numbers 1 through 6 appear sequentially in Window C.

NOTE

Window A is the rectangular display on the left which is labeled FREQUENCY MHz. Window B is the display in the middle and is labeled GAIN. Window C is the one on the right labeled NOISE FIGURE.

   c. The message FCAL appears for several seconds in Window B.
   d. A frequency value is displayed in Window A and some numeric value will flash in Window C.
5. Press the **PRESET** key. The message FCAL will appear momentarily in Window B and then the frequency value in Window A may change.
6. After these steps have been completed, if no error messages have appeared, the 2075 has successfully completed the Power-up Test.

5-5. NOISE DRIVE VOLTAGE TEST

This procedure measures the DC voltage at the NOISE DRIVE output connector on the front panel of the 2075. This voltage should be +28.00 volts plus or minus .050 volts.

A 5½ digit, digital voltmeter is required.

1. Set the POWER switch to the ON position.
2. Remove any devices connected to the RF INPUT.
3. Press:

   SPEC FUNC · 20.2 · ENTER

   This special function causes the 2075 to apply the noise drive voltage to the BNC connector. The green NOISE DRIVE LED will light.
4. Connect the DVM leads to the NOISE DRIVE connector and take the voltage reading.
5. The voltage should be + 28.00 volts DC ± .050 volts.
6. Press the ON/OFF key.
7. Verify that the green NOISE DRIVE LED is off and that the voltage at the NOISE DRIVE connector is less than + 1.0 volt DC.
8. This concludes the Noise Drive Voltage Test.

5-6. IF ATTENUATORS CALIBRATION

In this procedure the 2075 measures the changes in gain caused by adding different levels of internal IF attenuation and then stores those attenuator values.

No test equipment is required for this procedure.

1. Place the POWER switch in the ON position.
2. Remove any devices connected to the RF INPUT.
3. Press:

   SPEC FUNC · 19.1 · ENTER
4. The word CAL0 appears in Window B and the letters IF appear in Window C.
5. The words CAL1, CAL2, CAL3 and CAL4 will appear sequentially in Window B while the unit continues to calibrate its IF stages.
6. When a frequency value appears in Window A, and some numeric value begins flashing in Window C, this calibration procedure is successfully completed.

5-7. FINAL DETECTOR BIAS TEST

This procedure measures the bias voltage on the final detector.

No test equipment is required for this procedure.

1. Place the POWER switch in the ON position.
2. Press:

   SPEC FUNC · 37.5 · ENTER

   This causes the 2075 to place 55 dB of attenuation in its RF stage.
3. The value 55 dB should appear in Window B, and 0 dB should appear in Window C.
4. Press:

   SPEC FUNC · 39.5 · ENTER

   This causes the 2075 to place 45 dB of attenuation in its IF stages.
5. The value 45 dB will appear in Window C.
6. The value of the detector bias voltage is displayed in Window A. This voltage must be between .016 and .024 volts (16 to 24 millivolts). If the least significant digits of the display are changing too rapidly to read, add smoothing by pressing the **RIGHT ARROW** key several times.
7. The test is complete at this point but the 2075 must be taken out of the test mode by completing the following steps.
8. Press:

   SPEC FUNC · 37.0 · ENTER

9. Press:

SPEC FUNC 39.0 ENTER

10. Press the **F** key.

11. This concludes the Detector Bias Test procedure.

5-8. SECOND STAGE CALIBRATION

In the first part of this procedure frequencies and corresponding noise source ENR values are entered into an ENR table of the 2075 by the operator. Then the 2075 measures its own second stage noise figure at different frequencies and gain levels, and stores these values.

A calibrated noise source is required for this procedure.

Perform the following steps:

1. Select the noise source which will be used to make the measurements.

2. Apply AC power to the 2075.

3. Allow several seconds for the 2075 to complete its automatic power-up self tests. These are completed when the message FCAL has appeared in, and then disappeared from, Window B.

4. Press the **PRESET** key. Wait until the new FCAL message disappears from Window B, signifying that the frequency calibration is completed. Preset restores the control parameters to a set of known values.

5. Press:

   SPEC FUNC 5.1 ENTER

   This calls up, or activates, Table 1. The data about to be entered will be stored in Table 1 (5.2 would have called up Table 2 and 5.3 would have called up Table 3). The error message 104 may appear indicating that no data is currently stored. If so, it may be disregarded.

6. Press:

   ENR

   This places the 2075 in the mode which allows entry of the frequencies and ENR values. The red light in the center of the ENR key is illuminated. Also, the ENTER annunciator in Window A begins to blink signifying that the operator is required to enter a frequency.

7. Enter the first calibration frequency, in MHz, from the noise source calibration data sheet (for example, 10 MHz) by pressing:

   10 ENTER

   The frequency just entered appears in Window A. The ENTER annunciator in Window B begins to blink signifying that the operator is required to enter the ENR value, in dB, for the frequency just entered.

8. Read the ENR value for the frequency just entered from the noise source calibration data sheet, or the inscribed label on the calibrated noise source. Enter this value by pressing:

   numeric keys ENTER

   The value just entered appears in Window B. This completes the entries for the first frequency. The ENTER annunciator in Window A begins to blink, indicating that the next frequency should be entered.

9. Enter the next frequency, in MHz, from the noise source calibration data sheet by pressing:

   numeric keys ENTER

   The frequency just entered appears in Window A. The ENTER annunciator in Window B begins to blink, signifying that the ENR value for that frequency should now be entered. ENR values are always entered in decibels.

10. Enter the ENR value by pressing:

    numeric keys ENTER

    The value just entered appears in Window B. Now the ENTER annunciator in Window A will start to blink again, indicating that the next frequency should be entered.

11. Continue to enter paired frequency and ENR values for all data points shown on the noise source calibration data sheet.

12. After all the entries have been made, use the **DOWN ARROW** and **UP ARROW** keys to examine the entries for correctness. Step down through the table by pressing or holding the **DOWN ARROW** key. Step up through the table by pressing or holding the **UP ARROW** key.

    To clear an erroneous entry, first display it using the up or down arrow keys and then press the **CLEAR** key. Both the frequency and the ENR value will be cleared. Then enter the correct value. The **ENTER** key can be used to toggle the ENTER annunciator back and forth between Window A and Window B. See paragraph 3-31 for more information.

    To clear the entire table, press:

    SHIFT CLEAR

13. Press:

    ENR

    This takes the 2075 out of the ENR table entry and display mode. The red light in the center of the **ENR** key will go out. This completes the entry of ENR data. Continue with the following steps to perform the Second Stage Calibration.

14. Connect the noise source to the RF INPUT connector and the NOISE DRIVE connector. Press:

    CALIB

15. The 2075 will now display an FCAL, CAL0, CAL1, CAL2, and CAL3 as it performs these steps of the calibration process.

16. During the CAL1, while the unit takes 20 MHz steps, verify that the noise figure displayed in Window C is less than 7.0 dB ± .001 dB/MHz from 10 MHz to 1850 MHz. The noise figure at 1850 MHz should be less than 8.85 dB. As the 2075 steps up to 1900 MHz, the noise figure may go above 8.85 dB.

17. During the CAL2, while the 2075 takes 20 MHz steps across the frequency band, verify that the noise figure displayed in Window C is less than 13.0 dB from 10 MHz to 1850 MHz.

18. During the CAL3, while the unit takes frequency steps across the band, verify that the noise figure displayed in Window C is less than 28.0 dB from 10 MHz to 1850 MHz.

19. After the 2075 has completed the CAL3, it will return to the start frequency and display values for corrected noise figure and gain. Since nothing has been inserted between the calibrated noise source and the RF INPUT, these values should be 0, with slight random variations.

This concludes the Second Stage Calibration Procedure.

5-9. FINAL DETECTOR LINEARITY TEST

This procedure measures the linearity of the final detector by adding different levels of IF attenuation. For each level, the 2075 measures its own noise figure and the output voltage of the final detector.

NOTE

The output of the detector is specified to be linear for an output voltage range of .20V to 4.98V. As attenuation is increased a point will be reached where the OFF voltage is less than .20V. The resulting noise figure may still be the same as previous values since the detector is usually linear beyond the specified range of .20V to 4.98V. If the OFF voltage goes below .20V, verification of noise figure accuracy is no longer necessary.

A calibrated noise source is required for this test.

The 2075 must be warmed-up for at least 10 minutes before performing this test.

1. Place the POWER switch in the ON position.

2. Connect the calibrated noise source to the RF INPUT.

3. Tune the 2075 to 30 MHz by pressing:

   30 ENTER

   Window A will display 30 MHz.

4. Press the **F** key. This puts the 2075 into the uncorrected noise figure mode.

5. Press the **RIGHT ARROW** key four or five times to add smoothing and slow the random changes of the noise figure value now displayed in Window C.

6. Record the noise figure value displayed in Window C. This value should be less than 6 dB.

7. Press:

   SPEC FUNC 20.2 ENTER

8. The value now displayed in Window A is the output voltage of the final detector. Verify that this value is less than 4.98 volts. Window B displays a 0 indicating that no attenuation is being applied to the RF stage. Window C displays some value which is the amount of attenuation being applied to the IF stages, usually 5 or 10 dB.

8a. Press the **ON/OFF** key.

The green NOISE DRIVE light will go out.

8b. Verify that the voltage now displayed in Window A is greater than .20 volts.

8c. Note the value of IF attenuation displayed in Window C. Use the following table to determine which special function will be required to enable the next higher value of IF attenuation.

SPECIAL FUNCTION	IF ATTENUATION
38.0	Auto-ranging
38.1	0 dB
38.2	5 dB
38.3	10 dB
38.4	15 dB
38.5	20 dB
39.0	Auto-ranging
39.1	25 dB
39.2	30 dB
39.3	35 dB
39.4	40 dB
39.5	45 dB

8d. If the value displayed in Window C is 5, then enter Special Function 38.3 to enable the 10 dB IF attenuator.

9. Press:

   SPEC FUNC 38.3 ENTER

   This will place 10 dB of IF attenuation in the line. Window C displays a 10.

10. Verify that the detector voltage displayed in Window A is less than 4.98 volts.

11. Press the **ON/OFF** key.

    The green NOISE DRIVE light will go out.

12. Verify that the voltage now displayed in Window A is greater than .20 volts.

13. Press the **F** key.

    This returns the 2075 to the Noise Figure measurement mode. The green NOISE DRIVE light will begin to blink.

14. Record the noise figure value displayed in Window C. This value should be virtually equal to the value recorded in Step 6.

15. Press:

    SP FN   38.4   ENTER

    This places 15 dB of IF attenuation in line. Window C will display 15 dB.

16. Verify that the detector output voltage, displayed in Window A, is less than 4.98 volts.

17. Press the **ON/OFF** key.

    This turns off the noise drive voltage and causes the green light to go out.

18. Verify that the detector output voltage displayed in Window A is greater than .20 volts.

19. Press the **F** key.

    This returns the 2075 to the noise figure measurement mode.

20. Record the noise figure value displayed in Window C.

    This value should be virtually the same as those recorded in Steps 6 and 14.

21. Press:

    SPEC FUNC   38.5   ENTER

    This will place 20 dB of IF attenuation in the line. Window C will display 20 dB .

22. Verify that the detector output voltage displayed in Window A is less than 4.98 volts.

23. Press the **ON/OFF** key.

    This turns off the noise drive voltage.

24. Verify that the detector output voltage displayed in Window A is greater than .20 volts.

25. Press the **F** key.

26. Record the noise figure value displayed in Window C. This value should be virtually equal to the values recorded in Steps 6, 14, and 20.

27. Press:

    SPEC FUNC   38.0   ENTER

    This returns the 2075 to its attenuation auto-ranging mode.

This concludes the Final Detector Linearity Test.

5-10. SCOPE/PLOTTER OUTPUT TEST

This test verifies the proper functioning of the X, Y, and Z outputs which are used to drive an external oscilloscope or plotter.

This procedure requires either a dual channel oscilloscope with an X-Y mode or an X-Y plotter.

1. Locate the BNC connectors marked X, Y, and Z on the rear panel of the 2075. Install test cables between these and the X, Y, and Z inputs of the oscilloscope.

2. Locate the INT (INTENSITY) adjustment on the rear panel on the Eaton 2075. Rotate it fully clockwise.

3. Place the 2075 POWER switch in the ON position. Upon power-up the 2075 will automatically output a test pattern.

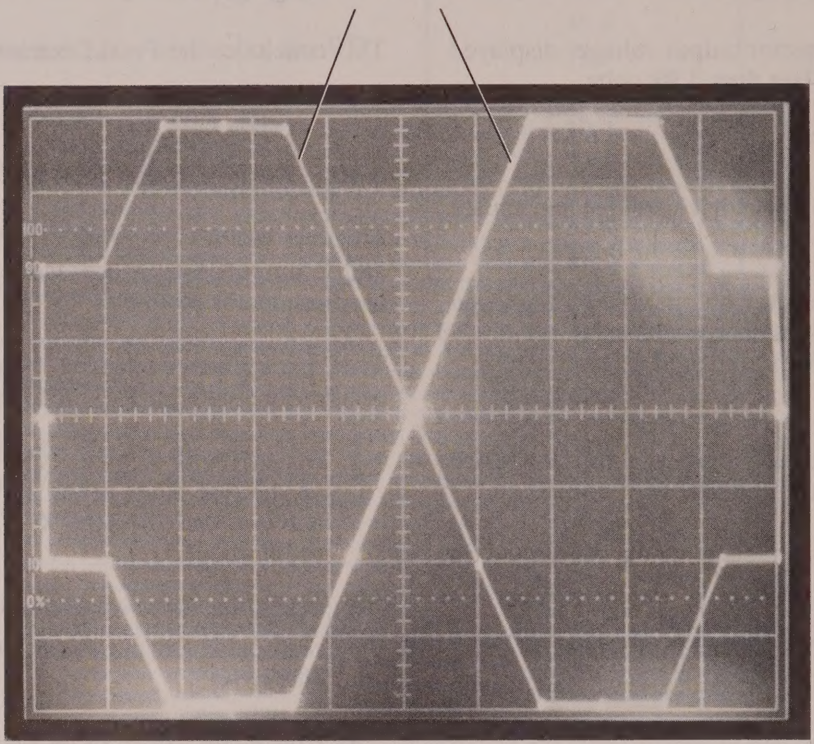
4. Adjust the amplitude controls on the oscilloscope so that the test pattern fills the display. It may be necessary to adjust the INT control on the rear of the 2075 to obtain a visible pattern.

NOTE

> For this test to work properly, the oscilloscope must reduce its intensity with a positive-going TTL signal applied to its Z input.

5. Adjust the INT potentiometer on the 2075 to dim half the test pattern.

6. The displayed test pattern should look like the one shown in Figure 5-1.



Difference in intensity is obtained by adjusting the 2075 rear panel INTENSITY control.

Figure 5-1. OUTPUT TEST PATTERN 2

7. Disconnect the test cable from the Z input of the oscilloscope.

8. Press:

   SPEC FUNC | 7.5 | ENTER

9. A dot will appear in the lower left corner of the oscilloscope display. This is the first alignment point used for aligning an X-Y plotter.

10. Press:

    SPEC FUNC | 7.6 | ENTER

11. A dot will now appear in the upper right corner. This is the second alignment point used for aligning an X-Y plotter.

This concludes the oscilloscope/plotter output test.

This concludes the performance verification tests.